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Allocating non-monetary incentives for Navy Nurse Corps Officers : menu method vs. bid method Combinatorial Retention Auction Mechanism (CRAM)

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THESIS

ALLOCATING NON-MONETARY INCENTIVES FOR NAVY NURSE CORPS OFFICERS: MENU METHOD VS. BID METHOD COMBINATORIAL RETENTION AUCTION MECHANISM (CRAM)

by

Marlow H. Levy

March 2010

Thesis Co-Advisors: William R. Gates
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ALLOCATING NON-MONETARY INCENTIVES FOR NAVY NURSE CORPS OFFICERS: MENU METHOD VS. BID METHOD COMBINATORIAL RETENTION AUCTION MECHANISM (CRAM)

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LIST OF ACRONYMS AND ABBREVIATIONS

AACN	American Association of Colleges of Nursing
ASN	Associate of Science in Nursing
BOOST	Broaden Opportunity for Officer Selection Program
BSN	Bachelor's Degree in Nursing
BSN	Bachelor of Science in Nursing
BUMED	Bureau of Navy Medicine
CAPT	Captain
CCNE	Commission on Collegiate Nursing Education
CDR	Commander
CERT	Certification
CLEP	College Level Entry Program
CNA	Center for Naval Analysis
CNO	Chief of Naval Operations
CRAM	Combinatorial Retention Auction Mechanism
CRNA	Certified Registered Nurse Anesthetist
DA	Direct Accession
DC	District of Columbia
DIRECT	Direct Commission in Navy Nurse Corps
DOD	Department of Defense
DUI/DWI	Driving Under the Influence/Driving While Intoxicated
DUINS	Duty Under Instructions
ENS	Ensign
FITREP	Fitness Report
FTE	Full Time Employee
FTOST	Full-time Out of Service Training
FY	Fiscal Year
GAO	Government Accounting Office
GPA	Grade Point Average
HM	Navy Hospital Corpsman
HPLRP	Health Professions Loan Repayment Program
HRSA	Health Resources and Services Administration
ISP	Incentive Special Pay
IST	In-service Training

JO	Junior Officer
KTD	Known-to-Date
LCDR	Lieutenant Commander
LPN	Licensed Practical Nurse
LT	Lieutenant
LTJG	Lieutenant Junior Grade
MECP	Medical Enlisted Commissioning Program
MGIB	Montgomery GI Bill
MSA	Manpower Systems Analyst
MSN	Master of Science in Nursing
MTF	Medical Treatment Facilities
NC	Nurse Corps
NCLEX-RN	National Council Licensing Examination-Registered Nurse
NCP	Navy College Program
NJP	Non-judicial Punishment
NKO	Navy Knowledge Online
NLNAC	National League of Nursing Accrediting Commission
NMC	Naval Medical Center
NMI	Non-monetary Incentives
NNC	Navy Nurse Corps
NNCAP	Navy Nurse Corps Anesthesia Program
NROTC	Navy Reserve Officer Training Command
PA	Prisoner A
PB	Prisoner B
PE	Physical Education
PERS	Bureau of Navy Personnel
PRT	Physical Readiness Test
RADM	Rear Admiral
RN	Register Nurse
SNE	Senior Nurse Executive
SO	Senior Officer
SSC	Subspecialty Code
STA-21	Seaman to Admiral Program 21

USN	United States Navy
VA	Veterans Administration
YOS	Years of Service

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I. INTRODUCTION

A. BACKGROUND

1. The Nursing Shortage in America

The current political climate in the United States has heated to a boiling point over healthcare reform, specifically targeting the insurance industry. However, another crisis in healthcare looms on the social and political horizon. It is one of the most monumental challenges facing the United States healthcare industry, the shortage of professional registered nurses. The nursing shortage has become a crippling agent for many already struggling hospitals nationwide. Hundreds of healthcare professionals and medical experts hypothesize about the cause of the shortage. It seems to be the product of a multitude of dynamic variables affecting the availability of professional nurses throughout the industry. Some clearly, identifiable factors include the exodus of experienced nurses, the absence of nurse educators, the bottleneck in the admission of new students, and the supply and demand constraints of the civilian nursing market.

Moreover, the nursing shortages are having a direct effect on access to care, cost, and quality of care in healthcare organizations throughout the country. A study by the National Center for Health Workforce Analysis, states that the nursing workforce shortage is growing and will critical proportions beginning in 2010, and continue to worsen at least through 2020. Additionally, the report suggests that this will be the worst nursing shortage in American history by 2010 (Bellack, 2007). Nurses are the backbone of the healthcare industry. They represent one of the largest suppliers of labor in the industry. A hospital cannot operate without a stable supply of competent, highly skilled, and dedicated nurses. The fallout of the shortages does not simply affect the medical community of major cities and big states. It is a national crisis. Only five states in the country, Hawaii, Iowa, Kansas, Kentucky, and New Hampshire are actually projecting

enough supply to meet their demand for nurses. All the other forty-five states are projecting a moderate to severe shortage with Wyoming experiencing the worst (Bellack, 2007).

	2000	2005	2010	2015	2020	Change from 2000–2020
Licensed RNs	2,697,000	2,752,000	2,795,000	2,781,000	2,705,000	0%
RNs providing nursing services or seeking employment in nursing	2,249,000	2,303,000	2,305,000	2,250,000	2,163,000	-4%
FTE RNs providing nursing services	1,891,000	1,943,000	1,941,000	1,886,000	1,808,000	-4%

Table 1. Projection of Registered Nurses from 2000–2020 (From: Nursing Supply Model by the National Center for Health Workforce Analysis)

The nursing shortage could not have come at a worse time due to the identical phenomenon occurring in other medical professions, such as doctors, dentist, and administrators. In addition, the American population is aging as a whole and experiencing an increase in life expectancy. They are presenting to healthcare facilities with more complex diseases and co-morbidities, which require extensive and sometime sophisticated medical care. There appears to a quiet storm lurking on the horizon for the American public. Katherine Mangan from the Chronicle of Higher Education, referred to a report, based on numbers from The U.S. Department of Health and Human Services in 2004. She states, “The U.S. could face a shortage of nearly one million nurses by 2020, which may be more than the industry could bear. The shortages would come at a time when the aging population will need more care” (Mangan, 2007).

Consequently, “age” will be a major contributing factor to shortages in the healthcare industry itself, as well as the general population. The professional nursing population is getting older on average. Their ability to perform labor-intensive tasks will decline, as well as their ability to work long hours. Both of these elements are of importance to the profession because they are common requirements when performing basic nursing duties. The average age of the RN population was over 46 years old, in 2004 (Service, 2007). Secondly, the baby boomer generation makes up a large proportion of the present nurse workforce. In the next 5–7 years, retirements among this generation

is expected to excel rapidly. These older, more experienced nurses seem to be retiring earlier to pursue other dreams as they enjoy an increased life expectancy. The ranks of the nursing profession will shrink considerable if this occurs. The current national economic crisis has somewhat slowed the pace of nursing retirements. However, as the markets change, financial fears subside, and the overall economy improves, those nurses posed to retire will resume their plans.

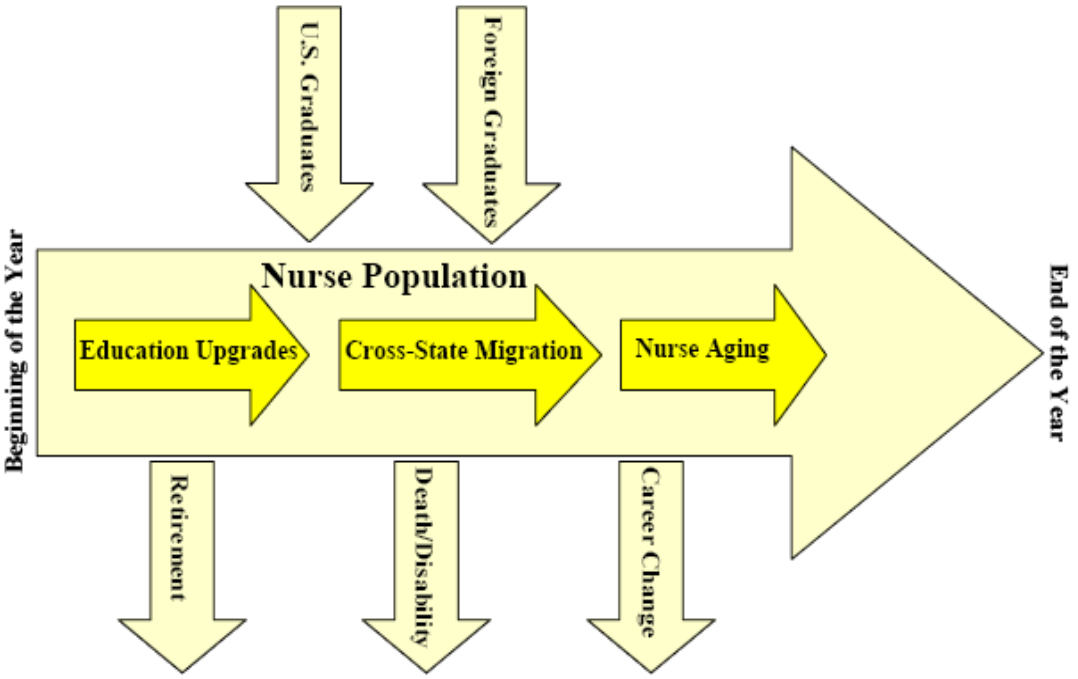

Figure 1. Factors Affecting the Nursing Population (From: Nursing Supply Model by the National Center for Health Workforce Analysis)

One of the solutions to the shortage problem also seems to pose a serious challenge in itself. A simple solution would be to increase the number of new nurses. In the long run, enrolling college students in professional nursing programs across the country should alleviate the shortage. Therefore, many private and public organizations invested large amounts of capital in marketing campaigns aimed at achieving this objective. However, they soon discovered that nursing programs around the country were simply not producing enough new qualified registered nurses to meet the demand.

In addition to a shortage of staff nurses in hospitals and clinics, there is an even greater demand for nurse educators. Nationally, nursing schools are turning away thousands of qualified applicants due to a shortage in capacity and nurse educators. In a statement from the American Association of Colleges of Nursing (AACN) in 2006, 37,514 students were turned away or denied admission from Nursing Baccalaureate programs in 2005, as opposed to 3,600 in 2002 (Service, 2007). Nurse educators at the university level typically have graduate degrees in a nursing specific area of study. Therefore, there is a lag in the time required to produce new educators, train them for specific areas of nurse education, and place them in classrooms.

Along with nursing schools turning away qualified applicants, some potential candidates with a desire to be a nurse do not apply. Most Baccalaureate nursing programs are heavily focused in science and critical thinking skills, along with the traditional aspects nursing care. Therefore, a large number of prospective candidates prefer to pursue a program, such as Licensed Practical Nursing (LPN). It is less intensive, shorter in length, and lacks the major scientific requirements of a four-year program (Service, 2007). The shortage of nursing faculty at the university level will prove to be even more severe than the crisis facing staff nurses in hospitals. Nursing programs around the country will be limited in expansion capabilities, effectiveness of academic and clinical programs, and academic research and development.

2. The Nursing Shortage in the United States Navy

The medical professionals that make up Navy Medicine are in high demand throughout the nation. Their skills and professional credentials make them a sought after commodity for civilian employment. Nursing professionals represent the largest portion of the professional medical community. In turn, the Navy must continually compete for these highly competent and well-trained professionals. For the past decade, competition has dramatically increased, with the civilian market offering new nurses a number of creative incentives to influence their decisions. They have been successfully winning the

battle for new nurses. However, recent economical phenomena have creative a slight paradigm shift toward more secure industries such government agencies, including the Department of Defense.

B. PURPOSE

1. Issues of Retention in the Navy Nurse Corps

It is important to define retention in the military medical community as it relates to officers. A definition extracted from the Government Accountability Office describes retention in the military as the military services retaining service-members with the necessary skills and experience (GAO, 2009). The status of retention in the Navy Nurse Corps (NNC) at this time is considered "high," according to manpower experts within the community. However, this pseudo improvement in nursing retention is a temporary function of the economic downturn. The current economic recession that is rippling throughout the United States has forced many Nurse Corps officers to reconsider retirement plans. However, it must be noted that as the financial markets improve, economic fears slowly subside, and the overall economy recovers, many of those nurses will retire.

2. Reasons for Attrition, Separation, and Retirement

At this moment, however, the crisis has left a large number of senior nurses in place, and junior nurses with little room to grow professionally. Traditionally, new nurses were given numerous avenues of professional pursuit after completing their first 1–2 years in clinical areas, such as medical/surgical wards, intensive care units, and other patient care specialties. However, they currently find themselves assigned to basic nursing duties in clinical areas for longer periods of time. In turn, many junior NC officers feel ignored, neglected, or generally dissatisfied with the direction their careers are going. They see little potential for future growth and become disenchanted with their Navy nursing careers. A large number of Junior NC Officers separate from active duty service after only one, initial tour.

Another group affected by a lack of motivation to remain on active duty are the prior-enlisted NC Officers. Many new NC officers began their Navy careers as enlisted service members. They aspired, planned, and worked their way up through military ranking structure and earned a commissioning in Navy Nurse Corps. Their leadership skills and professionalism are honed at the deck plates and carried into the Nurse Corps through one of several commissioning sources. Many of these NC officers find themselves facing the option of retirement after the required ten years of obligated service is complete. After giving much of their adult lives to Navy, and at least ten years to the Nurse Corps, they discover a void in their motivation to stay. Additionally and surprisingly, they find little to no incentive programs offered to them for continued service in the Navy Nurse Corps.

The Junior Nurse Corps Officers that separate after their first tour, and the prior enlisted officer that retire make up the majority of the pool of mid-level officers that would have been senior officer in four to six years. Therefore, a large shortage is forecasted for senior NC Officers in the next five to 10 years. Annually, the NNC set its target accession and retention goals. The average retention goal for mid-grade Lieutenants (O-3) is about 65 percent. Therefore, the NNC wants to retain 65percent of these officers, so they will be available for the LCDR (O-4) boards. In 2009, the NC promoted 90 percent of LTs to LCDRs, which is a very high percentage based on past board statistics. Possibly, a direct result of the shortage of LT's (O-3), many of which are those junior nurses that separated after their first tour or disenchanted prior-enlisted officer that retired.

The NNC was forced to promote the ones they had in inventory in 2009. It is a trend that is most likely going to be seen again in the next 2–4 years. In turn, this means that promotions should be getting better for most junior NC officers, yet it may also dilute the quality of senior officers. Incentive programs that target retention will be at the center of any strategy to confront the issue of manpower shortages in the Navy Nurse Corps community. A mechanism or program, such as CRAM, that's designed to effectively increase retention and save cost will be valuable to any Navy community, especially one as unique as the Nurse Corps.

Direct Accession Goals Active Duty Nurses, Fiscal Years 2001 through 2008

Fiscal year	Navy			
	Goal	Achieved	Percentage of goal met	Percentage of goal exceeded or not met
2001	100	99	99.0	-1.0
2002	90	90	100.0	0.0
2003	72	72	100.0	0.0
2004	91	59	64.8	-35.2
2005	99	55	55.6	-44.4
2006	102	85	83.3	-16.7
2007	71	73	102.8	2.8
2008	57	85	149.1	49.1

Source: GAO Analysis of Service Data

Table 2. Navy Nurse Corps Direct Accession Goals FY2001–2008 (From: GAO Analysis of Service Data)

3. Attempts to Address Retention in Nurse Corps

The NNC have attempted to address retention in number of ways over the years. CDR Lawrence Bateman, the Manpower Systems Analyst community Specialty Leader stated that, "retaining junior NC Officers with 3–6 years of service, at the level of junior and mid-grade lieutenants (LT) has been a problem for the past 10 years. There is a major gap in the number of mid-grade LT, and this affects promotion and training. Mid-Grade LTs are the mentors and trainers for new NNC Ensigns (ENS) at most Navy medical treatment facilities (MTF). Their absence leaves the NC with many incidences of "Ensigns training Ensigns" (L. Bateman, personal communication, 2010).

Retaining NNC Officers with prior-enlisted experience beyond their eligibility to retire period is another concern for the community. At this time, officers with prior enlisted experience are eligible to retire after 10 years of service. Many of them choose to retire, rather than extend their time on active duty. They cite a number of reasons for retiring, and many of them are non-monetary in nature. Additionally, there are not many

incentives, monetary or non-monetary, aimed at retaining this group of invaluable officers. For example, CDR Bateman discussed, a friend's retirement from the Navy as soon as he was eligible because he could not get the orders he wanted. "He wanted to stay in the Portsmouth, VA area but the community detailer wanted to move him because he hadn't been to a certain level command i.e., "A Big Three," so he decided to get out. The idea of moving his family again was too much" (L. Bateman, personal communication, 2010). The "Big Three" refers to the Navy three largest medical treatment facilities, Naval Medical Center Portsmouth in Virginia, Naval Medical Center San Diego in California, and National Naval Medical Center Bethesda in Maryland.

According to CDR Bateman, the NNC has some promising retention tools that have shown to be affective. However, they have not dramatically decrease the separation or retirement rate (L. Bateman, personal communication, 2010). The Health Professions Loan Repayment Program attempts to address the financial concerns of new officers that come into the Navy education related debt. The Incentive Specialty Pay has help increased the number of NNC officers retained with knowledge, skills, and abilities identified as mission critical, yet does not address the most desired groups, junior officer without a specialty or prior-enlisted officers eligible for retirement. These programs will be discussed in more detailed, later in Chapter II.

Some of the issues with structuring and implementing new incentive programs for NC officers are the cost of these programs, leadership support, and measurements of effectiveness. Costing out incentive programs, especially certain non-monetary benefits, such as sabbaticals, telecommuting, and childcare is difficult. In most cases, the administrative cost and other intangible cost could prove almost impossible to identify (L. Bateman, personal communication, 2010). Setting up a system that effectively assesses, supports, and measure the success of these incentive programs may also require resources, which are already limited.

Moreover, the perception of the NNC leadership could also create some challenges. If leadership does not feel a crisis is looming it becomes quite difficult to obtain support and more importantly, allocation of proper resources. Retention is relatively high overall due to the current recession and civilian unemployment numbers

(L. Bateman, personal communication, 2010). Therefore, the perception could be that retention is not a pressing issue. Additionally, retaining quality nurses is not deemed to be concerning. According to CDR Bateman, there are mechanisms in place to "weed out the poor performers or behavioral issues" (L. Bateman, personal communication, 2010). He states, "PRT failures, drug related incidences and NJP's, FITREPS, incompetence noted in personnel records, etc, generally takes care of the low quality nurses. It's really pure numbers" (L. Bateman, personal communication, 2010). He believes that quantity or increase number of available nurses is at the heart of the issue.

In a Senate Appropriations Committee's defense subcommittee, Rear Admiral (lower half) Christine M. Bruzek-Kohler, the Director of the Navy Nurse Corps, reported a healthy force of Navy Nurse Corps officers. Although, there is a national shortage of nurses in the country, all three services reported successful attainment of their recruitment and retention goals. Rear Admiral Bruzek-Kohler, spoke of new incentive and training programs that "will help boost those numbers even further" (Bruzek-Kohler, 2009). She explained further, "the active-duty *Navy nurse* corps is staffed at 96 percent and made its accession goal for the third year in a row and the Reserve component met 107 percent of its recruiting goal in 2008. However, deficits from the three previous years have led to challenges filling junior officer billets" (Bruzek-Kohler, 2009).

C. THE RESEARCH QUESTIONS

The research questions addressed in this thesis look to present alternative strategies for Navy Nurse Corps leaders and Manpower Systems Analyst to assess, implement, and measure, monetary and non-monetary retention incentives targeting specific groups. Furthermore, it examines the decision- making behaviors of individuals in an experimental environment, the effectiveness of Combinatorial Retention Auction Mechanisms, and how it may utilized in the Navy Nurse Corps community. In this thesis, some basic assumptions are made before conclusions can are drawn. The first is that the individuals in the experiment are a fair representation of the military community. The

second is that Navy Nurse Corps Officers value the same or similar Non-monetary Incentives (NMI) as the individual in the sample. Finally, that Navy Nurse Officers will behave the same or similar to the individuals in the sample.

1. The Primary Question

What is the independent and interdependent effect of monetary and non-monetary incentives on Nurse Corps Officers utilizing a uniform and discriminatory partial information auction mechanism?

2. Secondary Questions

The secondary research questions look to examine specific issues in the NNC community related to value for NNC officers, decision-making behavior of NNC officers, retention of specific groups within the NNC community, and possible cost-effectiveness of a program, such as CRAM.

- Do Nurse Corps (NC) Officers value the same monetary and non-monetary incentives as Surface Warfare Officers?
- How do NC Officers behave when presented with a menu of monetary and non-monetary incentives?
- Can a Combinatorial Retention Auction Mechanism (CRAM) program be utilized to improve retention among Junior Navy NC officers and NC officers with more than eight years of prior-enlisted experience?
- What combination of monetary and/or non-monetary incentives would be both, valued by Nurse Corps Officers and cost-effective to Navy Medicine?
- What are the cost savings associated with utilizing an auction mechanism, such as CRAM, for Navy Medicine?
- Can utilizing an auction mechanism such Menu Method or Bid Method CRAM increase the number of senior minority officers in the Navy Nurse Corps.

D. SCOPE, LIMITATIONS, ASSUMPTIONS AND METHODOLOGY

The scope will include: (1) a review of the current status of the Navy Nurse Corps community, (2) a review of previous studies and reports related to Navy Nurse Corps

retention, experimental economics, and auction mechanisms, and (3) analysis of data obtained from the labor market experiments based on Combinatorial Auction Mechanisms. The thesis will conclude with a summary, conclusion, and recommendations for further study.

The research is limited based on the mixed demographics of the pool experimental participants. Most of the labor market experiments were performed with a variety of individuals that attend or work at the Naval Postgraduate School. Furthermore, none of them was NNC officers. We make the broad assumption that Navy Nurse Corps officer will behave similarly under the same conditions. A Government Accountability Office survey and report is the primary resource used to determine what NNC officer's value and how they may behave when making decision in a Menu Method or Bid Method CRAM experiment.

This thesis is a part of the continuing research being conducted by Dr. William Gates, Dr. Peter Coughlan, and Dr. Noah Myung related to Combinatorial Retention Auction Mechanisms. The research methodology used in this thesis will consist of the following steps.

- Conduct a literature search of books, naval officer retention studies, reports. Journal articles, and other literary information resources
- Conduct a thorough review of Nurse Corps retention efforts and identify needs common to other officer communities
- Conduct literature search on previous studies and reports related to auction mechanisms and experimental economics.
- Conduct labor market experiments to obtain data on individual and cohort decision-making behavior related to selecting monetary and non-monetary incentives.
- Analyze the research data from the experiment and identify trends. Identify potential usage of auction mechanisms for Nurse Corps officers based on experimental data.
- Present findings.

E. ORGANIZATION OF STUDY

A thorough literature review of the materials, ideas, concepts, and perspectives covered in this thesis is presented in Chapter II. It will examine the nursing shortage in civilian sector, as well as the United States Navy. Chapter II also give a brief clear picture of retention in the Navy Nurse Corps, the means by which leadership is addressing it, and a brief introduction to Auction Mechanisms, CRAM, and experimental economics. The theme of Chapter III is Retention Mechanisms. It defines, examines, and describes auction mechanisms, monetary and non-monetary incentives, and CRAM in more detail than previous chapters. Chapter IV briefly describes experimental economics and details the nature, conduct, and results of the labor market experiment used for this thesis. The final Chapter V presents draws conclusions about the experiments, summarizes the thesis, and make recommendations for further research.

II. LITERATURE REVIEW

A. THE PROFESSIONAL PERSPECTIVE ON THE NURSING SHORTAGE

The literature reveals a continual requirement for human capital in the global nursing community. The military medical force is ultimately representative and supplied by the civilian medical workforce. Simply stated, if there is a shortage of new registered nurses in the civilian sector then this has a direct negative effect on the ability for the Navy to recruit nurses. The Health Resources and Services Administration (HRSA) suggest that the current shortage of nurses in this country will continue to grow with severity over the next 20 years (HRSA, 2004).

Therefore, the NNC must continually compete with the civilian healthcare industry to recruit qualified nurses and in turn, achieve its manpower objectives. Historically, registered nurses have been in high demand and diminish supply since the end of World War II. The supply and demand of registered nurses in the United States has only reach equilibrium twice since the 1940s (Turner, 1990). The HRSA reports, absent an aggressive intervention, the supply of nurses in America will fall 36 percent (more than 1 million nurses) below the requirement by the year 2020 (HRSA, 2004).

Nursing programs across the country cannot produce enough nurses to meet the current demand. A brief from the Oxford Analytica Daily Brief Service stated that a shortage of healthcare workers, including registered nurses are likely to continue (Service, 2007). The problem with recruitment and retention is based on a multitude of dynamic and complex issues that affect the current labor market. A study by the National Center for Health Workforce Analysis, states that the nursing workforce shortage is growing and will critical proportions beginning in 2010, and continue to worsen at least through 2020 (Bellack, 2007). Additionally, the report suggests that this will be the worst nursing shortage in American history by 2010 (Bellack, 2007).

The generational differences are one of those key variables. There are marked differences in expectations, work ethics, compensation, company loyalty, lifestyle

choices, labor relations, and the balance between work and leisure time (Sudheimer, 2009). The "Baby-Boomers, Generation X and Y, and the Millennials" all place distinctively different demands on employers based on their expectations. The "boomers' make up the majority of the professional nursing labor force and their exercising their options to retire at an increasing rate. Generation X, Y, and the Millennials will be groups that employers must now target and their needs are completely different and diverse (Sudheimer, 2009). Any organization requiring the skills of a registered nurse must address this generation gap.

Another relevant issue affecting future recruitment and ultimately, retention of nursing staff across the healthcare industry is the professional nursing education system. Many professional nursing schools around the country are turning new applicants away due to faculty staffing shortages. A statement from the American Association of Colleges of Nursing (AACN) in 2006 stated, 37,514 students were turned away or denied admission from Nursing Baccalaureate programs in 2005, as opposed to 3,600 in 2002 (Allen, 2008). The increase demand for nurses has not coincided with an increase in nurse educators. Allen, further explains the main reasons for the lack of faculty to meet the demand for more nurses include the increased age of the current faculty and the declining number of years left to teach, expected increases in faculty retirements, less compensation for academic teaching than positions in clinical areas for master's and doctoral prepared nurses (Allen, 2008).

B. BRIEF HISTORY OF THE NAVY NURSE CORPS

1. Historical Highlights of the Navy Nurse Corps

In order to address the causes, effects, and any future inventions it is important to examine the history of Navy Nurse Corps, its organizational structure, and current climate. Although, nurses were not new to the United States Navy, the Navy Nurse Corps (NNC) was officially, established on May 13, 1908 by an act of Congress. The first group of individuals commissioned as Navy Nurses were twenty women, later known as the "Sacred Twenty." Until this time, nurses served in a number of roles as civilian

volunteers during the Civil War. It was not until World War II, that the number of Navy Nurses would begin to swell to its peak strength of 1386 in 1918 (Whiteclay, 2000). However, the number of nurses decreased dramatically at the end of the war. Their number declined to between 400–500 active duty personnel.

Navy nurses were there on the infamous day of December 7, 1941. They were on the ground at Pearl Harbor when the Japanese attacked, and begin immediately treating the injured and dying. Throughout the war, the NNC numbers would grow to an all time peak level of 11,086 nurses on active duty by 1945, serving at 40 naval hospitals, 176 dispensaries, and six hospital corps schools in the United States (Whiteclay, 2000). A female corps of caregivers was stationed all over the world from Europe to Asia dispensing care to military's sick and injured. In April 1947, the Army Navy Nurses Act established the Nurse Corps as a permanent staff corps of the U.S. Navy bringing permanent commissioned rank and equal pay, and then began to admit men into the Nurse Corps in November 1964. By the late 1990s, there were over 5,000 active duty and reserve nurses in the U.S. Navy and continuing to grow strong (Whiteclay, 2000).

2. Status and Structure of Today's Navy Nurse Corps

Today, the Navy employs over 5,000, active duty and reserve Nurse Corps officers (Houde, 2010). They represent a diverse group of men and women dedicated to the service of saving lives. Currently, 2,694 nurses serve on Active Duty in a variety of specialties, subspecialties, and challenging work environments (Houde, 2010). They serve as mental health nurses, medical and surgical nurses, emergency and trauma nurses, critical care nurse, certified nurse anesthetist, nurse practioners, education and training nurses, manpower systems analyst, and a host of other administrative and operational assignments. Today's Navy Nurse Corps officer is a highly skilled and competent, respected, diverse, well trained, highly educated, and well compensated professional. The following chart depicts the multiple nursing specialties within the NNC, which also require specific degrees of higher education.

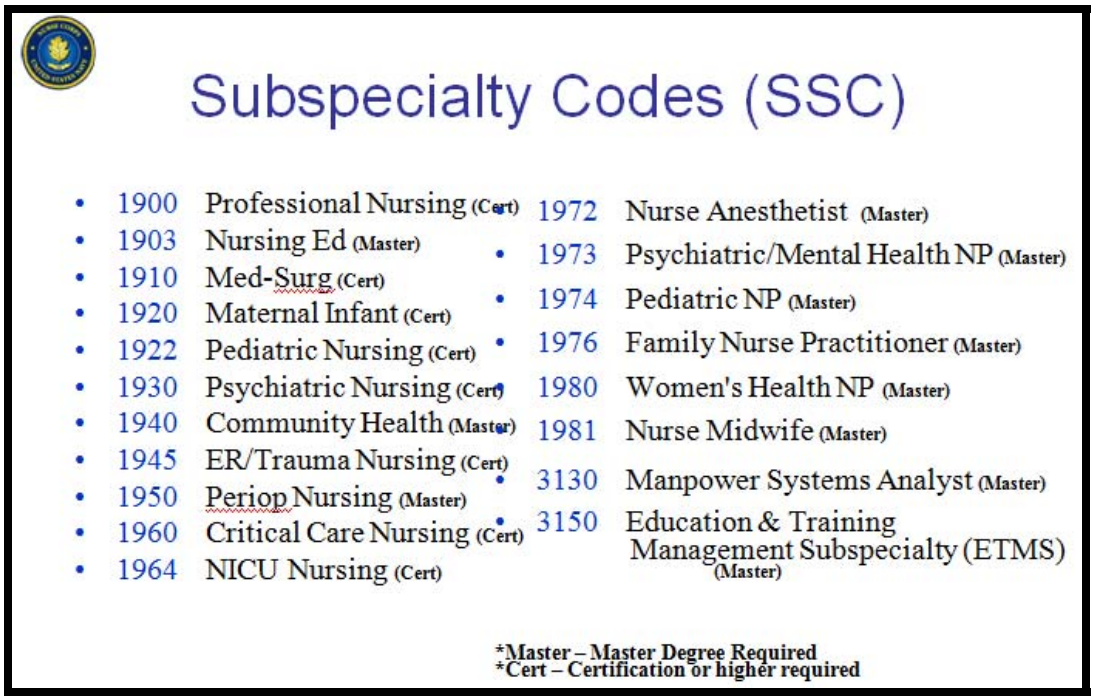

Figure 2. Subspecialty Codes (SSC) (From: NKO: United States Navy Nurse Corps, SSC, AQD's and Record Management)

The organization of the Navy Nurse Corps begins with the Director of the Navy Nurse Corps, a two-star Admiral that reports directly to the Surgeon General of the Navy. The Deputy Director, several Assistants, several regional executives, and a large number of Senior Executives support the Director in implementing the policies of the Bureau of Navy Medicine. These executives serve throughout the country and internationally at military medical treatment facilities (MTF), medical support commands, and other operational or administrative roles. The following organizational chart displays a graphical depiction of the NNC.

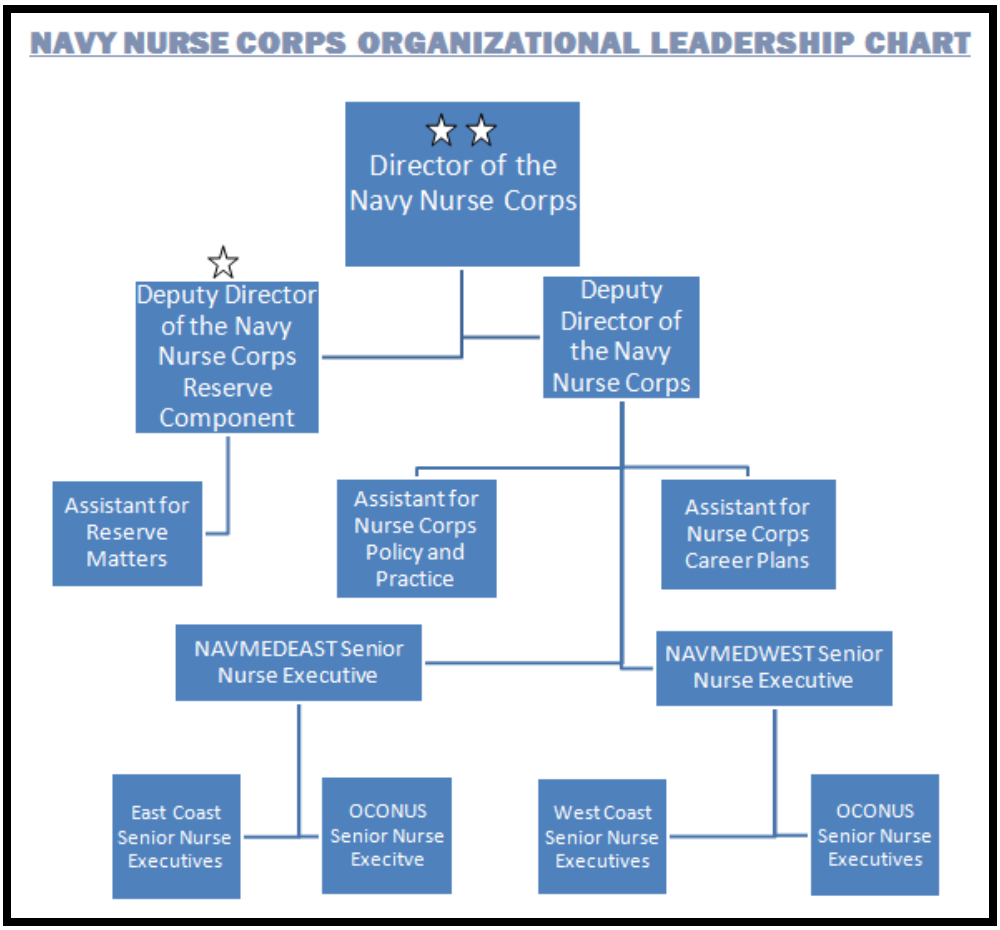

Figure 3. Navy Nurse Corps Leadership Organizational Chart

3. Accession Programs

In an effort to meet end strength, which is the number of active-duty military nurses in the Navy on the last day of the federal accounting period, the NNC tries to balance between the number of accessions, separations, and retained nurses. In FY2009, the NNC acquired 275 new nurses from its accession programs. The annual NC accession goals are to acquire between 250–260 new nurses. It equates to 250 new Ensigns (O-1), which if retained at 65 percent until Lieutenant (O-3) 5 years later, then the NC has 162 Lieutenants available for the Lieutenant Commander (O-4) promotion board. The following table illustrates the acquisition goals for FY2010–2015 of nurses from accession programs offered by the NNC (L. Bateman, personal communication, 2010).

ACCESSION GOALS FY10 – 15

	FY10 GOAL	FY10 Actual (per BUMIS)	FY10 KTD	FY11 GOAL	FY11 KTD	FY12 GOAL	FY12 KTD	FY13 GOAL	FY13 KTD	FY14 GOAL	FY14 KTD	FY15 GOAL
Begin Strength:	2815	2815	2815	2838	2838	2837	2837	2840	2840	2842	2842	2852
Gains												
DIRECT^	85	50	72	75		65		65		65		65
(DA) HPLRP	10		0	10		10		10		10		10
RECALL	10	1	8	10		10		10		10		10
NROTC	43	6	40	46	62	50	76	50	127	60	1	60
NCP	65	5	59	65	47	75	1	75		75		75
MECP	52	9	47	50	68	50	40	50		50		50
STA 21	10	2	11	16	15	18	18	16		16		16
HSCP	0			0		0		0		0		0
FTOST	0			0		0		0		0		0
FROM TNWO	0			0		0		0		0		0
IST	1	1		0		0		2		0		0
Other (PERS)	0	1		0		0		0		0		0
Total Gains:	276	75	237	272	192	278	135	278	127	286	1	286

Table 3. Active Navy Nurse Corps Accession Goals for FY2010–2015 (From: Navy Nurse Corps Webpage. Navy Knowledge Online. L. Houde. *NC Monthly Report January 2010*, Excel Spreadsheet retrieved on March 10, 2010.)

As mentioned in the previous chapter, currently military Manpower professional stated as "high." However, these recent gains do not offset or defer the forecast of a pending crisis in the NNC ranks. The NC did not meet the goal of 250 new accessions 5 years ago (2003–2005). Therefore, the available pool of Lieutenant Commanders for the 2008–2010 promotion boards will not meet the 162 Lieutenants that are required. The following table illustrates the number of NNC acquired from FY2004–2009 and their sources.

NC ACCESSIONS FY04–09						
	FY04	**FY05**	**FY06**	**FY07**	**FY08**	**FY09 Actual**
Begin Strength:	3108	3036	2932	2828	2804	2793
Gains						
DIRECT^ **(DA) HPLRP**	41	46	54 23	49 19	61 20	72 10
RECALL	18	9	8	2	2	4
NROTC	38	40	34	57	38	40
NCP	61	38	48	61	56	69
MECP	63	47	42	39	53	58
STA 21	1	9	19	28	14	21
HSCP	0	0	0	1	0	
FTOST	0	0	0	0	0	
FROM TNWO	0	0	0	0	0	
IST	0	1	2	0	2	
Other (PERS)	1	3	0	2	1	1
Total Gains:	**223**	**193**	**230**	**258**	**247**	**275**

Table 4. Active Navy Nurse Corps Accessions for FY2004–2009 (From: Navy Nurse Corps Web page. Navy Knowledge Online. L. Houde. *NC Monthly Report January 2010*, Excel Spreadsheet retrieved on March 10, 2010)

Several standard programs are used to acquire new nurses into the Navy Nurse Corps. These programs have been relatively unchanged over the past 10–15 years. The NNC relies heavily on accession programs to meet their annual end strength goals. The following is a list of the most common programs, a brief description, and their requirements.

a. Naval Reserve Officer Training Program (NROTC)

The Naval Reserve Officer Training Corps offers a four or two year scholarship for nursing students to complete a Bachelor of Science in Nursing. It will pay for tuition, fees, and books while providing a $250.00 monthly stipend to recipients and obligate to serve at least 4 years on active duty (NROTC, 2010). The following is a brief list copied from the NROTC webpage that states the basic requirements for the program (NROTC, 2010).

- U.S. citizenship
- Not less than 17 years old by September 1 of year starting college and no more than 23 on June 30 of that year
- Must not have reached 27th birthday by June 30 of year in which graduation and commissioning are anticipated
- Applicants with prior military service may be eligible for age adjustments for amount of time equal to their prior service, on month-by-month basis, for maximum of 36 months, if they will not reach 30th birthday by June 30 of year graduation and commissioning are anticipated
- High school graduation or equivalency certificate by August 1 of year of entrance into four-year NROTC Scholarship program
- No moral obligations or personal convictions that prevent conscientious bearing of arms and supporting and defending the Constitution of the United States against all enemies, foreign or domestic
- Physically qualified by Navy or Marine Corps standards
- Students w/30 or more semester hours or 45 or more quarter hours of college credit upon application or students already enrolled in NROTC College Program are not eligible for four-year NROTC Scholarships; these students should see professors of naval science at host university's NROTC unit to discuss other scholarship opportunities.

b. Direct Accession and the Health Professions Loan Repayment Program (DA and HPLRP)

The most direct means of entering the Navy Nurse Corps is through direct accession. An individual with a Bachelor or Master degree in nursing can apply for "direct" commission into the Navy Nurse Corps. Currently, the NNC is offering a college loan repayment program called the Health Professions Loan Repayment Program (HPLRP) to those nurses qualified for direct accession. They offer a $20,000 or $30,000 sign-on bonus, based on a three-year or four-year service commitment, respectively for direct accessions without the HPLRP. The other option is a $20,000 sign-on bonus and up to $40,000 to help repay nursing school loans, based on a five-year service commitment (Navy Nurse Corps, 2010).

c. Navy College Program (NCP)

The NCP is aimed at helping high school students enter the Navy Nurse Corps. The program will pay up to $34,000 for a student to attend an accredited nursing school. It offers eligible student an initial grant of $10,000 followed by $1,000 a month for 24 months (Navy Nurse Corps, 2010).

d. Medical Enlisted Commissioning Program (MECP)

According to the NKO website, MECP is a commissioning program offering qualified enlisted men and woman from all enlisted ratings a chance to earn an entry-level nursing degree followed by an appointment as an Ensign in the Nurse Corps. MECP is open to active duty enlisted sailors and marines with any rating or specialty. If accepting into the highly competitive program, individuals will receive full pay and benefits of their pay grades while going to school in pursuit of a Bachelor's Degree in Nursing (BSN). MECP students may use their Montgomery G.I. Bill, as well as other outside financial assistance to pay for schooling. The tuition, books, and fees are the responsibility of the member. Upon completion of their BSN, the officer candidate will be commissioned an Ensign in United States Navy Nurse Corps. They will incur an obligated service period of 2 years per 1 year of time in the program. They must pass the national Nursing Licensure exam, commonly called the NCLEX in order to practice as a registered nurse.

The requirements for the program are taken directly from the website and listed below.

- U.S. Citizenship (No Waivers)
- Opened to all rates and rank
- Applicant must be commissioned prior/before reaching their 42nd birthday (No Waivers)
- No high school transcripts are required. (NOT REQUIRED)
- At least 19 years of age

- A minimum of 30 semester hours (or 45 quarter hours) of undergraduate courses accepted for transfer towards a bachelor's degree in nursing (BSN) by the institution(s) for which you are applying. Courses, such as English, Psychology, Biology, Chemistry, Physiology, etc. are desirable.
- Cumulative GPA of at least 2.5 on a 4.0 scale
- SAT or ACT test taken within the past 3 years from application due date
- Must complete all requirements for a BSN within 36 months or less
- No history of felony conviction or any record of drug abuse. A driving under the influence (DUI/DWI) violation is disqualifying if within four years of the application deadline, or convicted of any misdemeanors (except minor traffic violations) within three years of the application deadline.
- Have no record of courts-martial convictions or civilian felony convictions
- Security Clearance, contact your Security Management Office. JPAS security investigation printout is acceptable.
- Favorable endorsement from commanding officer (NKO, 2009)

e. Seaman to Admiral Program (STA-21)

The Seaman to Admiral program is designed to help highly motivated and well qualified enlisted sailor earn a college degree and enter the active duty commissioned ranks. The program was begun in earnest, in 1994. It was the brainchild of, then Chief of Naval Operations (CNO) Admiral Mike Boorda. Admiral Boorda was the only Chief of Naval Operations to rise to that prestigious post from the enlisted ranks. He believed in the leadership capabilities and professional qualities of the enlisted sailors.

The Broaded Opportunity for Officer Selection and Training or BOOST program with the Nurse Corps option was one of the many enlisted commissioning programs that merged into the STA-21 program (STA-21, 2009). The current STA-21 program offers selectees the advantage of continuing to receive their current military pay, allowances, and special pays, while also paying up to $10,000 a year for tuition, fees, and books at an accredited nursing school that is NROTC affiliated. They are eligible for enlisted advancement opportunities while in the program; in addition, participants are authorized to use their Montgomery GI Bill (MGIB) benefits to offset cost not fully

covered by the program. Upon completion of the STA-21 program with the Nurse Corps option, candidates are commissioned as active Ensigns in the United States Navy Nurse Corps (STA-21, 2009).

The following requirements are taken directly from the Nurse Corps community webpage on the website Navy Knowledge Online (NKO, 2009).

- Applicants must be at least 18 years old and be able to complete degree requirements and commissioned by age 42
- STA-21 Nurse Corps Option participants are exempt from the two semester Calculus, but are required to meet the math and science requirements of their Nursing degree program
- The STA-21 Nurse Corps Option is available only at specially identified NROTC affiliated colleges or universities with nursing programs that confer a Baccalaureate Degree in Nursing that is accredited by the National League for Nursing Accrediting Commission (NLNAC) or the Commission on Collegiate Nursing Education (CCNE)
- Applicants must have a cumulative grade point average (GPA) of 2.5 on a 4.0 scale and have accepted by the university to which applying, a minimum of 45 quarter, or 30 semester credit hours in undergraduate nursing prerequisite courses (general English, general math, psychology*, biology*, chemistry*, organic chemistry*, anatomy and physiology*, microbiology*, nutrition*, sociology*, PE class, and history; although some of these courses fit your general degree requirements, it is very important to get the science (*) classes completed in order to be prepared to enter into the sequential nursing curriculum). Credit hours may be a combination of traditional classroom courses, College Level Entry Program (CLEP) credit, on-line or distance learning programs, or military training credits provided the school to which the application is made accepts the non-traditional credits.
- Upon completion of the Bachelor of Science Nursing degree, member must successfully pass the National Council Licensing Examination-Registered Nurse (NCLEX-RN) as required by SECNAVINST 1120.6 Series. Professional licensing is required to practice nursing
- Minor physical defects, non-organic in nature, may be waived. A person who is drug or alcohol dependent, abuses drugs or alcohol, or whose pre-service abuse of drugs or alcohol indicates a proclivity to continue abuse in the service or who has a record of any drug trafficking offenses is ineligible.
- STA-21 Nurse Corps Option selectees will incur a five-year active duty obligation upon commissioning

4. Retention Programs

a. Duty Under Instruction—Full Time (DUINS)

The DUINS program is one the most popular and effective tools the NNC has for retaining mid-grade officers. Each year the program solicits applications for approximately 70 opportunities for a Nurse Corps officer to attend graduate school. Highly qualified candidates are offered full military pay and benefits based on their current rank. If selected for the program, the Navy Medical Department pays full tuition and fees an accredited university for the specific nursing specialty they were selected for (NKO, 2009). Time in the DUINS program counts toward time in rank for promotion purposes in addition to retirement. After graduation, an obligated service period is determined based upon the program and the amount of time required to graduate (NKO, 2009).

b. Health Professions Loan Repayment Program (HPLRP)

HPLRP is a retention tool used to address the shortage of junior to mid-grade Nurse Corps officers. HPLRP is an accession and retention program that assists in the repayment of qualified tuition and educational expense loans in exchange for an obligated period of active duty (NKO, 2009). Personnel submit a request for the repayment of their qualified student loans via a selection board or committee. If selected for the program the officer is obligated to serve a minimum of two years active duty service.

c. Incentive Specialty Pay (ISP)

ISP enhances the Navy Nurse Corps ability to retain certain nurses with critical skills and education. It targets specific specialties within the Navy Nurse Corps community that are determined to be in critical need. Critical need specialties are areas of nursing, such as psychiatric nursing, Peri-operative nursing, critical care nursing, Family Nurse Practitioners, Pediatric Nurse Practitioners, women care providers, and Mental health Practitioners. There are essentially two types of ISP's (NKO, 2009). The CRNA-

ISP targets Certified Nurse Anesthetist and RN-ISP are aimed at all other critical need specialties. The programs pay a monetary bonus to specialty trained Nurse Corps Officers who meet eligibility requirements in exchange for an obligated period of active duty within that specific specialty of one to four years as defined in the contract. The program pays between $5,000 to $20,000 per to individuals with less than 12 months of initial obligated service in exchange for an additional 1 to 4 years of active duty service (NKO, 2009).

d. Navy Nurse Corps Anesthesia Program (NNCAP)

NNCAP is a highly coveted program in the Navy Nurse Corps community. The applicants are selected from a highly qualified pool of candidates to attend the Uniform Services University in Washington, D.C.. The program is national recognized, annually as the third best program in the country by "U.S. News and World Reports." It allows Navy Nurse Corps Officers to attain their master's degree and advanced practice license as a Certified Registered Nurse Anesthetist (CRNA) while receiving full pay and allowances (NKO, 2009). The Navy Medical Department pays tuition. The time spent in the program counts toward time in rank for promotion purposes and retirement. After graduation, individual must obligate themselves to 4.5 years of service.

C. MAJOR RETENTION CONCERNS FOR THE NURSE CORPS

The issues of retaining junior Navy Nurse Corps (NNC) officers, has consistently plagued the Nurse Corps community for more than two decades. Essentially, this is not a new phenomenon, but simply one that is becoming increasingly more palpable. In 1990, LCDR Penny Turner, noted in a Master thesis, at the Naval Postgraduate School that the difficulties experienced by the Nurse Corps in recruiting junior officers and the inability to retain them after their obligation periods was resulting in a large gap in the middle grades (Turner, 1990). Furthermore, the research suggested that the Navy Nurse Corps

focus more attention on retention efforts of junior officers versus recruiting. At that time, the NNC was meeting 90 percent of its recruiting goals, yet have no measurement for assessing its retention efforts (Turner, 1990).

Currently, retaining prior enlisted NNC officers is a major concern for Medical Manpower experts. Most, if not all prior enlisted Nurse Corps officers are eligible to retire from active duty after 10 years of obligated commissioned service. Furthermore, this particular demographic group of NNC officers represents those officers, significantly, more likely to be retained according a quantitative study conducted at that Naval Postgraduate School. However, there are very few monetary or non-monetary incentives offer to them when they are making their decision to stay in the Navy or retire. The majority of them acquire a commission via the Medical Enlisted Commissioning Program (MECP). LCDR Scott Messmer, a Navy Nurse Corps Manpower Systems Analyst, and Kimberly Pizanti in their Master's thesis, concluded that the MECP is one of two accession sources with the "greatest positive effect on active NNC retention (Messmer, 2007). Messmer and Pizanti were concerned that increasing the number MECP participants would not simply fix the problem. They predicted it would create another problem of decreasing the number of senior officers, since many prior-enlisted NNC officers exercise their right to retire after their obligation expires (Messmer, 2007). Their observation supports the need for monetary and non-monetary incentive programs aimed at this group of officers.

D. GAO REPORT ON MEDICAL OFFICERS ACCESSION AND RETENTION

In April 2009, the Senate Armed Services Committee received a detailed report from the Government Office of Accountability (GAO) called "Military Personnel: Status of Accession, Retention, and End Strength for Military Medical Officers, and Preliminary Observations Regarding Accession and Retention Challenges." The GAO was task to study the medical and dental personnel requirements for the Army, Navy, and Air Force (GAO, 2009). Furthermore, the organization was task with evaluating the medical workforce planning efforts throughout the Department of Defense to determine those

medical specialties that have experienced the largest gaps between their needs and fill rates. They were charged with reporting the challenges that hinder the services' ability to achieve their medical personnel goals, the plans each service has to resolve personnel shortfalls, and to examine the data from each service to determine whether they met their recruiting and retention goals. The full GAO Report is included in Appendix E. The follow chart illustrates the vast organizational structure of the Navy recruiting commands.

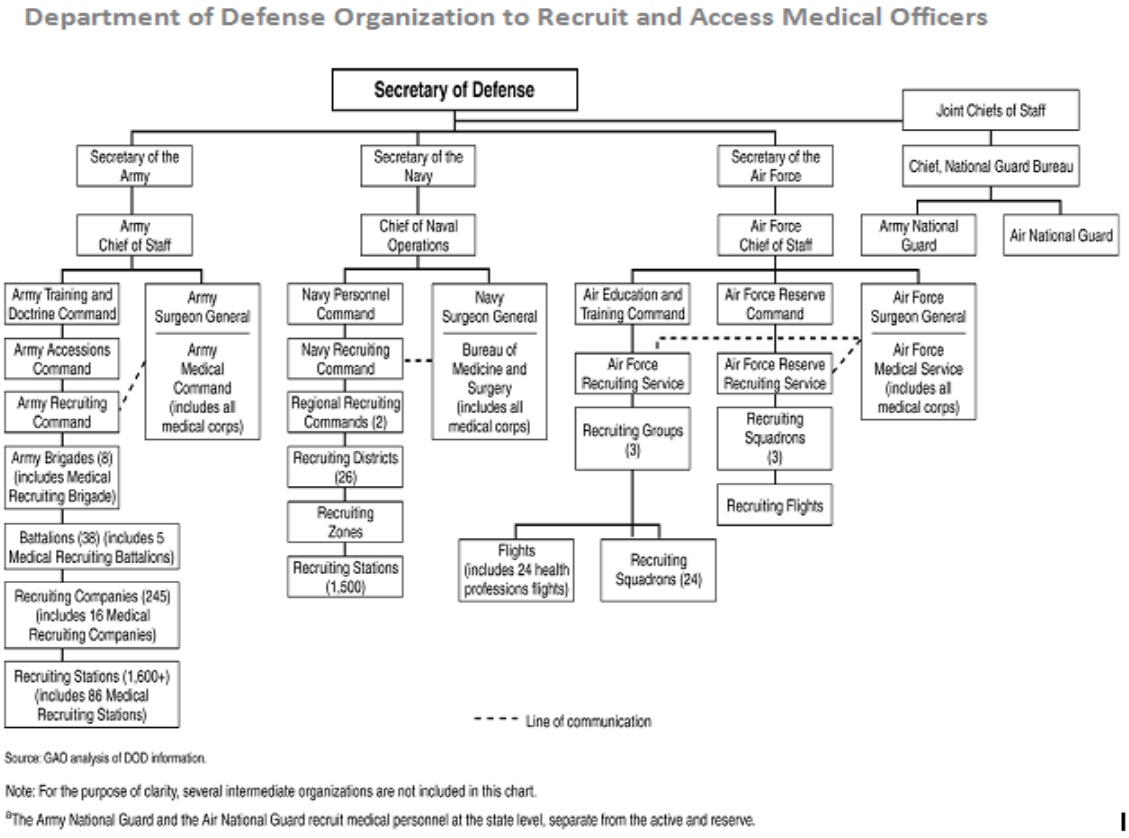

Figure 4. Organizational Chart for Department of Defense (From: GAO Analysis of DoD information. 2009)

The GAO report thoroughly examined the present state of the Military medical department accession and retention efforts and the challenges they face. The Navy Nurse Corps community was one of the areas reviewed in the report, specifically looking at the shortage, accession efforts, and retention issues. The review revealed that for fiscal years 2001 to 2008, the services did not meet most of their accession goals (GAO, 2009).

Furthermore, the active duty components of each service annual retention rates were between 87 percent and 94 percent. The active duty Navy specifically was consistently below its authorized end strength in four major areas, including Critical Care Nursing and Operating Room Nursing (GAO, 2009). The two specialties identified are mission essential to the NNC. In previous Chapters of this thesis, the conclusion was drawn that accession goals directly affect end strength, retention goals, and promotion opportunities for the Navy Nurse Corps. The GAO report concluded that there are a variety of reasons for the challenges faced in recruiting and retaining medical officers. They identified some of the difficulties are; (1) the limited supply of, and high demand for, qualified professionals; (2) the lower pay generally offered by the military compare to the private sector; (3) the stresses of deployment, and length and frequency of deployments; (4) the length of time they are required to commit to staying in the service (GAO, 2009). This thesis will show that some of these challenges become a major obstacle to retaining certain groups of NNC officers, also.

	Army				Navy			
Fiscal year	Goal	Achieved	Percentage of goal met	Percentage of goal exceeded or not met	Goal	Achieved	Percentage of goal met	Percentage of goal exceeded or not met
2001	160	113	70.6	-29.4	100	99	99.0	-1.0
2002	210	165	78.6	-21.4	90	90	100.0	0.0
2003	210	161	76.7	-23.3	72	72	100.0	0.0
2004	200	152	76.0	-24.0	91	59	64.8	-35.2
2005	170	128	75.3	-24.7	99	55	55.6	-44.4
2006	220	176	80.0	-20.0	102	85	83.3	-16.7
2007	210	177	84.3	-15.7	71	73	102.8	2.8
2008	200	296	148.0	48.0	57	85	149.1	49.1

Source: GAO analysis of service data.

Table 5. Direct Accession Goals Met by the Services for Active Duty Nurses, Fiscal Years 2001 through 2008 (From: GAO Analysis of DOD Information, 2009)

E. CENTER FOR NAVAL ANALYSIS NAVAL MEDICAL PERSONNEL SURVEY

The Center for Naval Analysis (CNA) conducted a survey of Navy Medicine Personnel via focus group in April 2009. The briefing was titled, "Navy Medicine: Are We Taking Care of Our People?" The discussions attempted to examine the perspectives of junior and senior Navy Medical personnel. The focus was on topics related to deployments, career expectations, leadership, mentorship/support, leadership training/transition, and retention (Whitmore, Hill, & Bickett, 2009). Specifically of interest to this thesis are the focus groups conducted with a targeted group of Navy Nurse Corps. The report yielded interesting conclusions relevant to retention of junior NNC officers and prior-enlisted NNC officers.

The target population in the study was junior NNC officers, Ensign to Lieutenant Junior Grade (O1–O3), prior-enlisted junior NNC officers (O1E–O3E), and Lieutenant Commanders (O4–O4E). The study identifies O4E as Lieutenant Commanders with prior-enlisted experience. However, although the study presents a rank of O4E, there is no current military rank for O4E. The population was formed from three locations including military medical centers and community hospitals, with 9 groups of 75 participants, of which 73 percent were O1–O3, 27 percent were O4, and 55 percent were prior enlisted officers (Whitmore, Hill, & Bickett, 2009).

The study found the overall Navy Medicine community was frustrated over the lack of predictability of assignments. Navy Nurse Corps officers specifically were frustrated due to conflicts in the organizational structure at some commands, nurses had no authority over the Hospital Corpsman (HM), which they are expected to lead (Whitmore, Hill, & Bickett, 2009). In many medical treatment facilities (MTF), the HM's are managed by a Chief (E-7) or other senior enlisted member, and the RN is left out of the decision loop. Prior enlisted NNC officers felt their leadership opportunities were limited after joining the NNC community because they were treated the same as all new junior nurses (Whitmore, Hill, & Bickett, 2009). They felt their experience and leadership capability was not regarded as valuable by Senior NNC leadership. Many of the officers

interviewed revealed that the perception of the NNC's limited understanding of family issues and concerns about the mismatch of assignments with career goals would affect their decision to stay in the Navy (Whitmore, Hill, & Bickett, 2009).

The studied focused heavily on the perceptions of junior and prior enlisted NNC officers. The officers in the study identified a number of challenges that may be address with the implementation of targeted non-monetary incentives or NMI's. The CNA study found that junior officers at medical centers felt they did not receive enough support from their leadership and some found difficulty in finding mentorship (Whitmore, Hill, & Bickett, 2009). They felt that the NNC was too competitive and some officers are reluctant to provide mentorship and guidance out of fear it may improve the odds of a junior officer or their peer receiving promotion opportunities beyond their own. A portion of them reported that, "if the highly competitive culture of NNC would change," they may be lead to stay in the Navy longer. Additionally, some junior NNC officer admitted that they rather go a prior enlisted peer for information and guidance versus their senior NNC officer. The full results of the CNA report can be viewed in Appendix C.

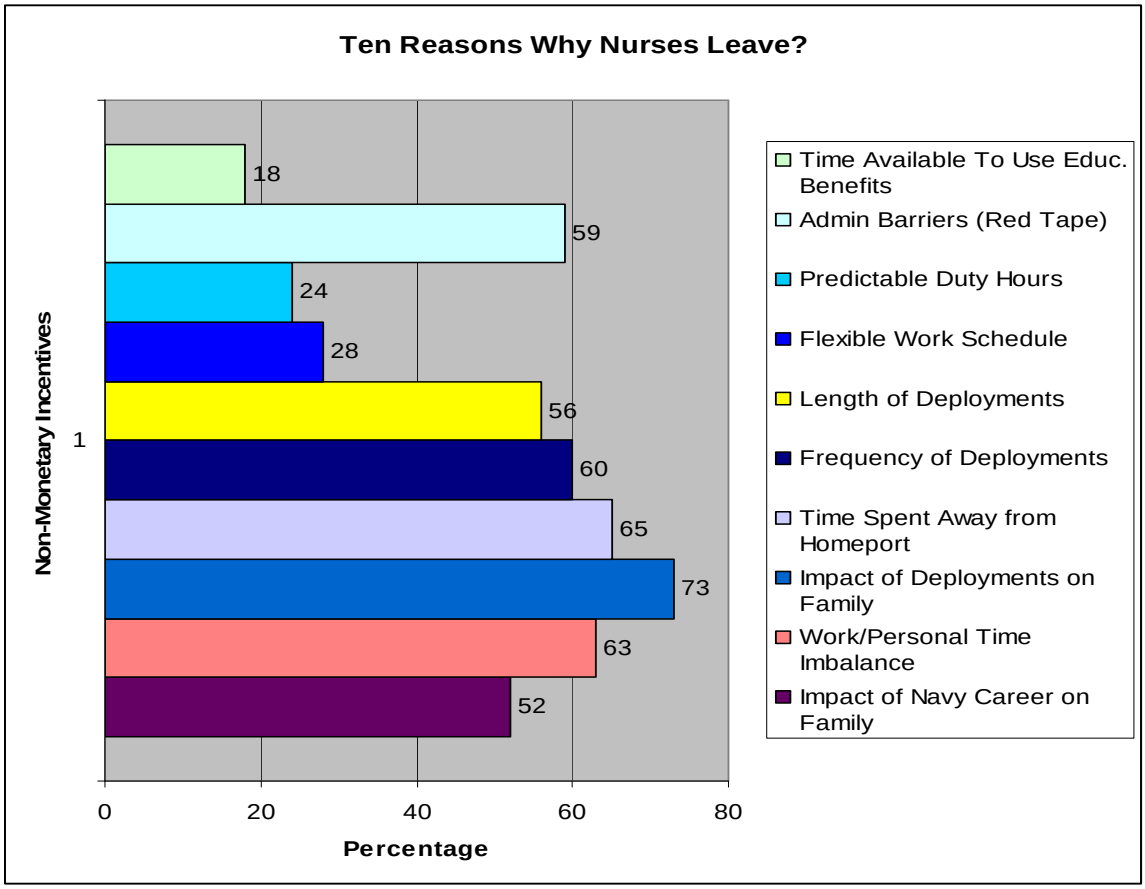

Figure 5. Reason Navy Nurse Corps Officers Leave the Navy

Most O1–O3 and O1E–O3E mentioned that the reason they joined the NNC was for financial reasons, such as better pay, educational funding, or to pay off college debts. Therefore, pay was not their noted reason for being dissatisfied with the NNC. Mostly, the nurses in the survey were not satisfied with the lack of availability in terms of mentorship and guidance from seniors. The competitive culture as it relates to advancement and promotion, the NNC's lack of empathy for family issues, lack of leadership opportunities for those prior enlisted officers, lack of flexibility when selecting nurses for deployment (voluntary vs. non-voluntary selectees), and lack of control when it comes to their career paths were cited as negative contributors to recruitment and retention. The CNA report found that incentives, such as retirement benefits, medical and dental benefits, patriotism, monetary compensation, job security, career assignment, sabbaticals, choice of assignments, and family support had a greater than 50 percent

positive effect on their decision to stay in the NNC. Most of the items identified by the junior NNC officers are NMI's (Whitmore, Hill, & Bickett, 2009). Additionally, they are identical or similar to the NMI's valued by other officer communities like Surface Warfare Officers, identified in previous studies (Browning & Burr, 2009). The full report released to the Navy Nurse Corps leadership at the Bureau of Navy Medicine is included in Appendix D.

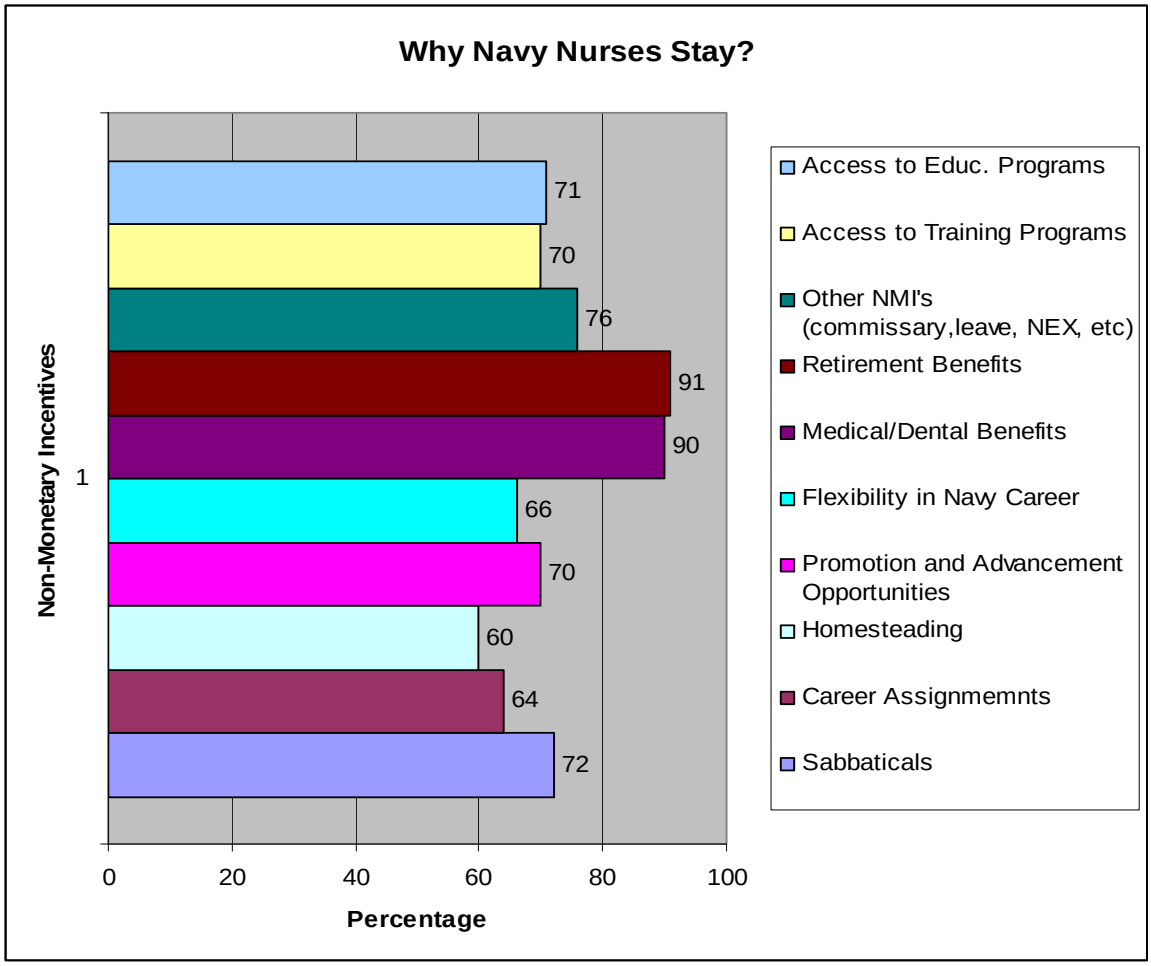

Figure 5. Reason Navy Nurse Corps Officers Stay in the Navy

F. AUCTION MECHANISMS

1. Defining Auction

The use of auctions, for the exchange of goods and services, is a practice dating back to ancient Greek civilizations. The idea or definition of auction can be found in many reference books, with vary degrees of similarities in them. For the purpose of this research, we will focus on one of the following similar description of an auction:

- According to Encarta Dictionary, an auction is "a sale of goods or property at which intending buyers bid against one another for individual items, each of which is sold to the bidder offering the highest price" (Encarta, 2010)
- Webster defines an auction simply as "the sale of property to the highest bidder" (Merriam-Webster, 2010)
- Oxford Dictionary online explains that an auction is "a public sale in which goods or properties are sold to the highest bidder" (Oxford, 2010)
- Planet Money, an online website looks at auction from a monetary angle. It explains, "an auction is also a process in which multiple parties bid to determine who will buy an item from a seller; generally, the bidder offering the highest price gets the item. Auctions can be open (bids are seen by other bidders) or sealed (bidders do not see other bids), and vary on many other dimensions. Auctions can be held when there are many identical items (such as securities); in this case, the price is set so that just enough bidders are willing to pay that price or higher to buy all of the units available. An auction can also be held where multiple sellers are selling an identical good to multiple buyers. Auctions are widely considered to be an efficient means of determining the fair value of an item" (Kwak, 2008).

In accurate terms and indeed more applicable to this thesis, we will define an auction as an exchange mechanism. Most generally, an auction is "an economic mechanism whose purpose is the allocation of goods (or services) and the formation of prices for those goods (or services) via a process known as bidding" (Henderson, 2007). Figure 6 depicts the many variations of an auction mechanism.

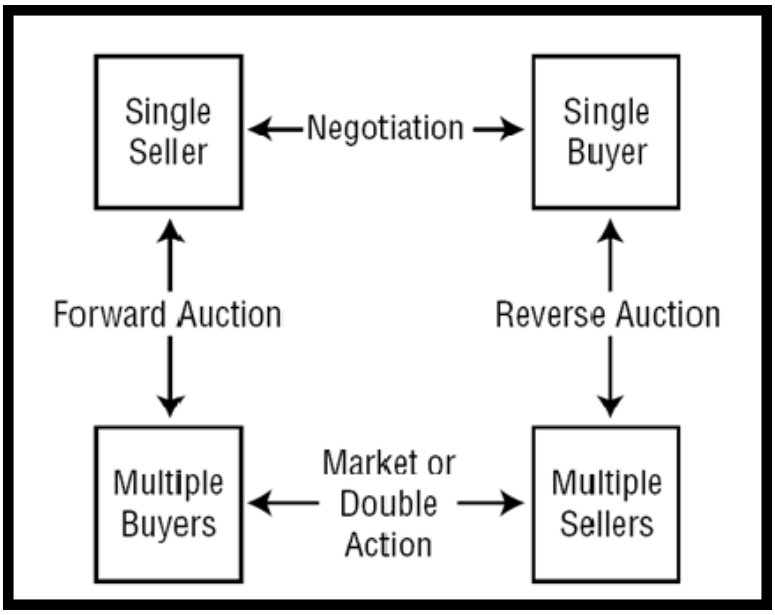

Figure 6. Auction Variations (From: Gates, Coughlan-Filip WEA, 2006)

G. EXPERIMENTAL ECONOMICS

The field of economics has grown to become one of most influential social sciences within the world of academia. In today's political and economically negatively charged climate, leaders are constantly looking to economist for answers to their most pressing questions; jobs, labor markets, real estate markets, financial markets; global trade policies, and much more. Wikipedia defines economics as "the social science which studies the production, distribution, and consumption of goods and services" (Wikipedia, Wikipedia: The Free Encyclopedia, 2010). It goes on to further define the term, with a quote from a 1932 essay by Lionel Robbins, which states Economics is "the science which studies human behavior as a relationship between ends and scarce means which have alternative uses" (Wikipedia, Wikipedia: The Free Encyclopedia, 2010). A more direct definition is that economics is the branch of social science that deals with the production and distribution and consumption of goods and services and their management (Wordnet, 2010). Therefore, economists are academic scholars and practitioners that study these economic conditions, labor market behavior, and human decision-making phenomena. Experimental economics is a relatively recent form of

examining economic phenomena. The idea that research in labor market behavior could be examined in a laboratory setting, actually began in the late 1940's and early 1950's. C.A. Holts describes it as, "the systematic evaluation of economic theories under controlled laboratory conditions" (Holts & Davis, 1993). Economist traditional use very sophisticated and time tested statistical models to examine the observable behaviors of "natural" markets. However, these models are unable to consistently, and accurately predict the small subtle behavioral changes that occur from the chaos inherit in natural data.

H. CHAPTER SUMMARY

The literature review detailed the current literature and scholarly information related to the national nursing shortage and its implications, retention of junior nurses in NNC, scarcity of resources in the NNC, a brief introduction to auction mechanisms, and a brief description of experimental economics. The purpose is to provide a clear direction for the methodological approaches used in this research. The reader should have a basic understanding, and foundational knowledge from the literature review to understand the background, purpose, and goals of this thesis.

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III. RETENTION MECHANISMS

A. INTRODUCTION TO AUCTION MECHANISMS

1. Types of Auctions

As research continues to provide valuable knowledge about the effectiveness and cost savings characteristics of auction mechanisms, they will become a vital tool for military manpower leadership and management. This chapter will explore the various types of auctions and briefly describe their characteristics. It is important to understand the different characteristics of auction mechanisms. Although, the Combinatorial Retention Auction Mechanism is the primary auction used in this research, it borrows a few characteristics from a number of different auction types. Figure 7 further describes the directional variations of an auction mechanism.

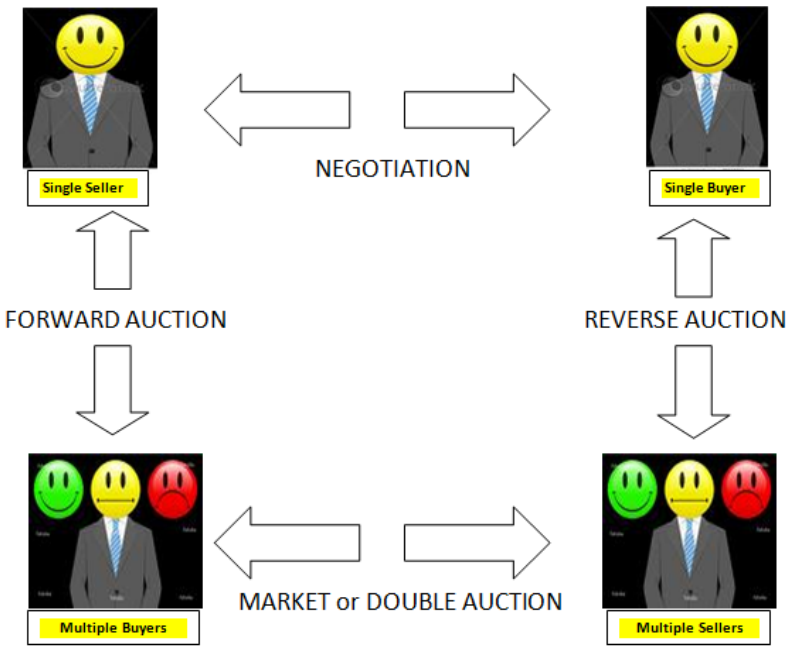

Figure 7. Auction Variations and Related Market Forces

a. Single-Winner Forward Auction

In this type of auction, there is a "single" winner and they are also the ***highest*** bidder. A forward auction is similar to the type of auction experience one may have on an internet site, such as Ebay or a merchandiser, such as Christie's auction house. It usually characterized by a single seller for multiple buyers. Ideally, the participant or buyer who places the most value on the good or service offered by the seller will bid the highest and win.

b. Single-Winner Reverse Auction

This type of auction tends to have a "single" winner; however, they are the ***lowest*** bidder. A reverse auction is characterized by a single buyer being able to select from the bids of multiple sellers. An example would be the United State Navy, which is a single buyer of manpower, and potential accessions are offering their services as sellers of manpower. One of the primary objectives of reverse auction is to drive prices downward. Figure 8 describes the most common types of auctions.

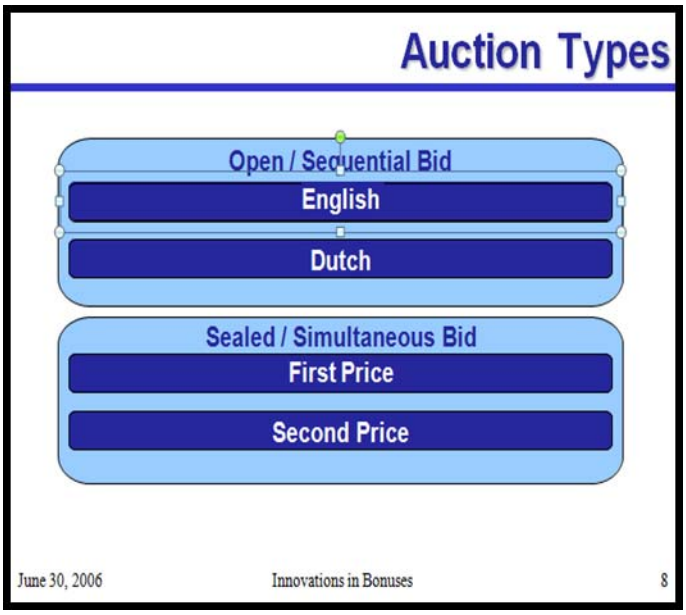

Figure 8. Types of Auction Mechanisms (From: Gates, Coughlan-Filip WEA, 2006)

2. Ascending and Descending Open-Bid Auctions

a. Ascending

Open Bid Auction (Ascending): The bidders ***openly*** *declare* the amounts they are bidding or their intentions. The auctioneer starts at a minimum amount and incrementally *increases* it until there are no more takers in the bidding process. The winner is the ***highest*** bidder. In an ascending-price auction, the agent can bid while the price is less than its lower bound, and drop out when the price is greater than its upper bound. Ascending auctions are often referred to as "English" auctions…

b. Descending

Open Bid Auction (Descending): The bidders ***openly*** *declare* their bids or intentions. The auctioneer starts at a high amount (one that no one is likely to take) and incrementally ***decreases*** it until a bidder accepts the price. Descending auctions are commonly called "Dutch Auctions."

3. Sealed-Bid Auctions

a. First Price

Sealed Bid Auction (First Price): Participants in the auction will submit bids, usually simultaneously, ***without disclosure (sealed)*** until a clear winner is determined. The winner will be the participant with the ***highest*** bid. In turn, the winner pays the amount ***they bid.***

b. Second Price

Sealed Bid Auction (Second Price Auction): Participants in the auction will submit bids, usually simultaneously, ***without disclosure (sealed)***, until the winner is determined. The winner will also be the participant with the ***highest*** bidder. However, the winner pays the amount bid by the ***second highest*** *bid* (or first excluded).

4. Reverse Sealed-Bid Second Price Auction

Reversed Second Price Seal Bid Auction: There is only one buyer (the Navy) with multiple sellers or bidder (the officers and/or their services). The bids are submitted ***without disclosure (sealed)*** until the winner is determined. The winner in this type of auction is the ***lowest (reverse)*** bidder. The price the Navy will buy those services will be at the rate of the ***second*** highest bidder. A reverse auction is one where multiple parties bid to determine who will sell an item to a buyer; in this case, the seller offering the lowest price gets to sell it (Kwak, 2008).

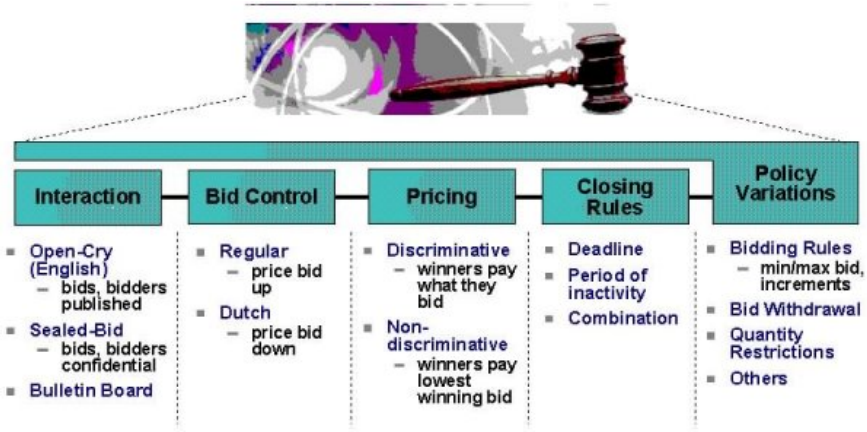

Figure 9. Types of Auctions Define by Actions of Bidder

5. Value Driven Bidding Strategies

It important to understand the optimal bidding strategies to examine individual decision making behaviors in simulations, experiments, and ultimately, implementing CRAM. In Zimmerman's (2008) research, she clearly illustrates in detail this optimal bidding strategy in second-price auctions and its effects on the process. These bidding strategies are humanistic economical behaviors where bidders seek to optimize their utility value by bidding at or above their true value in a second-price or first-price auction, respectively. Therefore, this further illustrates that a second-price auctions and CRAM specifically, can be applicable to any officer community, including the Navy Nurse Corps.

Zimmerman explains, under a second-price auction, the optimal bidding strategy is to bid your true valuation. For example, if you are bidding (in a forward auction) to purchase an item that is worth $30 to you (in other words, you would be willing to pay a maximum of $30 for the item), then your best strategy is to bid exactly $30 for the item in a second-price auction. To understand this result more clearly, this section will illustrate how a person can never do better than by bidding truthfully in a second-price auction. For simplicity, the explanation that follows employs the following notation (Zimmerman, 2008):

V = Your value for the object
P = Price paid for the object
S = Your surplus
B = Your bid for the object
H = Highest bid submitted by any other bidder

Figures 10 and 11 graphically depict the value to cost evaluation by a single bidder in an auction. The following section has been taken from Zimmerman's work on second-price auctions and CRAM. It will first demonstrate that bidding above one's true value, for example choosing (B > V) can only harm the bidder and bidding below one's your true value is harmful also, for example choosing (B < V) (Lay, 2009). The following figures illustrate three possible cases or outcomes, which can result from bidding above your true value, and three outcomes for bidding below your true value. Furthermore, if you do not submit the highest bid (i.e., if B < H), then S = 0. If you do submit the highest bid (i.e., if B > H), then P = H and your surplus is given by S = V - P = V – H (Lay, 2009). The explanations for bidding strategies and their valuations was taken from Lay (2009).

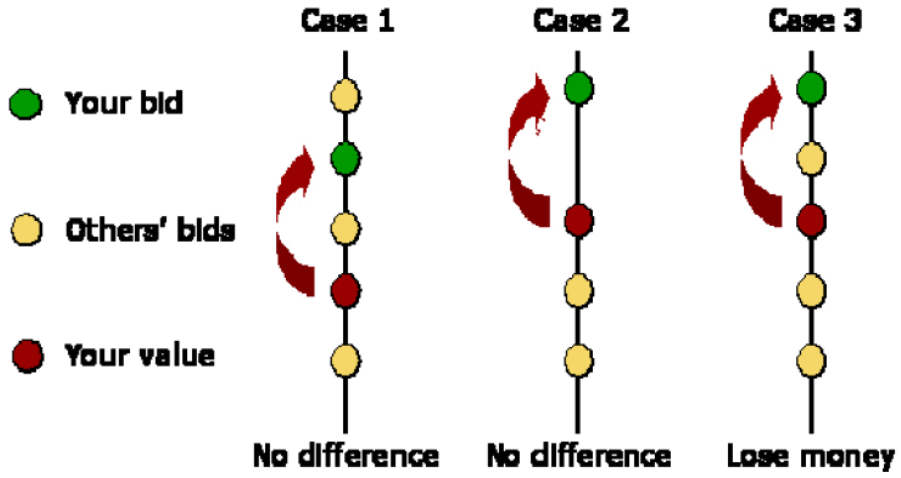

Figure 10. Bidding Above One's Valuation (From: Zimmerman, 2008)

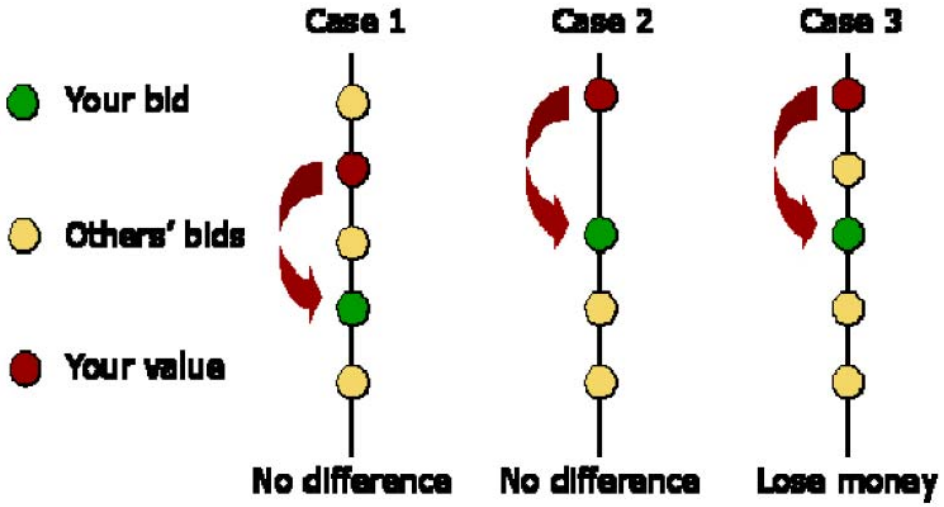

Figure 11. Bidding Below One's Valuation (From: Zimmerman, 2008)

a. Bidding Above Your True Value

In a second price auction, the idea is to maximize your surplus.

(1) Case A1. If H>B>V, then here, because H > B, you are not the high bidder and do not win the object, therefore S = 0. If you bid truthfully (B = V), you also do not win the object (because H > V), and therefore, would also have S = 0. Thus, bidding above your true value provides no benefit in this case.

(2) Case A2. If B>V>H, then here, because B > H, you are the high bidder and win the object, therefore S = V - H > 0. If you bid truthfully (B = V), however, you also win the object (because V > H), and therefore, would also have S = V - H. Thus, bidding above your true value provides no benefit in this case, either.

(3) Case A3. If B>H>V, then here, because B > H, you are the high bidder and win the object, therefore S = V - H, which is *negative*, because H > V: you "win" the object, but pay more than it is worth to you. If you bid truthfully (B = V), on the other hand, you would not win the object (because H > V), and therefore, would have S = 0. Thus, bidding above your true value hurts you in this case. You would be better off bidding truthfully.

b. Bidding Below Your True Value

(1) Case B1. If H>V>B, then here we find, because H > B, you are not the high bidder and donot win the object, therefore S = 0. If you bid truthfully (B = V), you also do not win the object (because H > V), and therefore, would also have S = 0. Bidding below your true value provides no benefit in this case.

(2) Case B2. If V>B>H, then here we find, because B > H, you are the high bidder and win the object, therefore S = V - H > 0. If you bid truthfully (B = V), you also win the object (because V > H), and therefore, would also have S = V - H. Thus, bidding below your true value provides no benefit in this case.

(3) Case B3. If V>H>B, then here we find, because H > B, you are not the high bidder and do not win the object, therefore S = 0. If you bid truthfully (B = V), on the other hand, you would win the object (because V > H), and therefore, would have S = V - H, which is positive because V > H. Thus, bidding below your true value hurts you in this case. You would be better off bidding truthfully.

As a result, the optimal strategy in a second-price auction, with a single winner, is to bid your true value. This result is easily extended to the case with multiple winners. In this case, all winning bidders are paid a price equal to the first excluded bidder (e.g., with 20 winning bidders, the 21st highest price). The opposite holds for a second-price reverse auction with multiple winners (e.g., with 20 winners the 20 lowest bidders are paid the amount bid by the 21st lowest bid). With multiple winners, this is referred to as a uniform price auction.

6. First-Price Sealed-Bid Reverse Auction Bidding Strategies

In a first-price sealed-bid reverse auction, the winning (lowest) bidder would win the auction and pay the price bid. In a reverse auction with multiple winners, the lowest price bidders would win the right to supply the item and they would be paid a price equal to their actual bid. This is referred to as a discriminatory price auction. At first glance, this would seem to be more cost-effective because the buyer is not over-paying for the lower cost suppliers.

However, the bidding strategy is more complicated for a first price sealed bid auction. The optimal strategy in the discriminatory-price auction is not to bid one's true value, but instead to raise your bid somewhat above your true value. Each individual should try to estimate what others are bidding and then bid just below the expected cutoff (the first excluded bid). This allows an individual to win the auction while maximizing their surplus. Note that if bidders are right on average, the discriminatory price auction yields the same total cost outcome as the uniform price auction. At the same time, a discriminatory price reverse auction may be more cost effective if bidders are risk averse. As risk aversion increases, bidders will lower their bids to increase their probability of winning the auction, even at the sacrifice of their expected. As a final issue, which should not be ignored, each winning bidder receives a different payment. In a retention bonus auction, the discriminatory-price auction mechanism creates unequal compensation and may result in morale issues and tension within the operating.

B. COMBINATORIAL RETENTION AUCTION MECHANISMS (CRAM)

Understanding the Combinatorial Retention Auction Mechanism will be the key to understanding how this tool can help the Navy Nurse Corps retain valuable human capital with the knowledge, skills, and abilities they require. Auctions were explained, briefly in previous chapters for recognition of their value. Tuomas Sandholm from the computer science department at Carnegie Mellon University says: Combinatorial auctions, that is, auctions where bidders can bid on combinations of items, tend to lead to more efficient allocations than traditional auction mechanisms in multi-item auctions where the agents' valuations of the items are not additive (Sandholm, 2002). The idea of Combinatorial Auctions was first proposed by Rassenti, Smith, and Bulfin (1982), for the allocation of airport landing slots (Combinational, 2010). This idea is further explained by Dr. David Park, in his dissertation at University Pennsylvania noted that auctions offer great promise as mechanisms for optimal resource allocation in complex distributed systems with self-interested agents (Parks, 2001). Although, his worked was related to the use combinatorial auction mechanisms in e-commerce, it remains relevant in explaining the diverse industries in which Combinatorial Auction mechanisms have been found to be effective.

1. Introduction to CRAM

Combinatorial Retention Auctions Mechanisms have been researched, defined, and explained in a number of theses. However, the most complete and detailed definition and explanation of this auction mechanism and the advantages of using CRAM, can be found in research performed by Coughlan, Gates, and Zimmerman (2008). Much of this introduction will focused on their research to understand the dynamics of an auction mechanism, such as CRAM. Yet, a brief explanation of the elements that make up CRAM may be appropriate at this time. Richard Lay (2009) explains that CRAM as previously explored is essentially comprised of three elements (Lay, 2009):

(1) A second-price auction that helps ensures accuracy when setting a bonus levels.

(2) A non-monetary incentive (NMI) component, which reduces cost for the Navy Nurse Corps to retain officers when the officer's value > cost for those NMI's offered.

(3) A combinatorial auction provides the individual with a more complete and valued incentive package with little or no "waste." (Lay, 2009)

2. The CRAM Process

The CRAM process is again a cost efficient and effective retention tool being tested in academic and experimental environments for possible use by Navy leadership. The process works as follows.

- A service member or Navy Nurse Corps Officer states:
  - The minimum cash bonus required to retain him or her in Navy.
  - Then, the acceptable reduction in the cash bonus for each non-monetary incentive they wish to obtain, including a combination or package of NMI's.
- The entity instituting the auction:
  - Calculates the minimum cost package for the bid they received. Keeping in mind that a bid package includes any NMI with a value > cost. The cash bonus is reduced by the value of the incentive included in the package. The cost of the entire package will be the cost of the NMI's and the provisional cash bonus.
  - Calculates the set of lowest cost packages submitted by service members, thereby, calculated which members cost the least to retain.
- Each service member or in this case Navy Nurse Corps Officer retained by the organization:
  - Receives the NMI they asked to be included in their package bid.
  - Receives the cash bonus equal to the total cost of the first-excluded bid package minus the cost of the NMI or NMI's they selected, in the uniform-price CRAM variants explored to date.

3. Example of CRAM

As further illustration of how the Combinatorial Retention Auction Mechanism operates, consider an example of the uniform-price CRAM retaining three Navy nurses and offering two NMIs, each costing the Navy $20,000. For this example, the Navy will retain two of these nurses and their NMI values are additive. Figure 10 illustrates such a scenario and how the uniform-price CRAM would be applied. The columns two through four in the figure show the nurses' cash only costs to retain, and the values they receive from each of two NMIs, respectively. In a purely monetary uniform-price retention auction, the nurses would bid their true reservation values (column two). Thus, nurses 1 and 2 would be retained at a bonus equal to nurse 3's bid ($100,000), and the total cost to retain two nurses would be $200,000. Figure 12 demonstrates the decision-making process in clear numerical detail.

Sailor #	Min. $ to Retain	Incentive 1 Value	Incentive 2 Value	Total Incentive Cost	Total Incentive Value	Revised Min. $ to Retain	Total Cost to Retain	Cash Bonus	Total Value Received
1	$80K	$40K	$10K	$20K	$40K	$40K	$60K	$60K	$100K
2	$90K	$10K	$30K	$20K	$30K	$60K	$80K	-	-
3	$100K	$30K	$40K	$40K	$70K	$30K	$70K	$40K	$110K

Figure 12. Decision Making Behavior in the CRAM Process (From: B. Zimmermen. 2008)

Under the uniform-price bid method CRAM, on the other hand, the sailors would also bid their true value for each of the NMIs; nurse 1 would be allocated NMI 1, nurse 2 would be allocated NMI 2, and nurse 3 would be allocated both NMIs, resulting in the NMI costs and values shown in columns five and six, respectively. The military would then reduce the cash incentive bids by the nurses' bids for the NMIs allocated, resulting in the revised cash retention bonuses depicted in column seven. The Navy's cost to retain each nurse, their revised cash bid plus the cost of the selected NMIs, is show in column

eight. Nurse 2 would be separated under CRAM and becomes the first excluded retention cost for the retained nurses, a cost of $80,000 per nurse. Hence, CRAM reduces the total cost to retain two nurses to $160,000, saving $40,000 with just two nurses.

The final two columns in the figure show the cash bonus paid to each retained nurse (the military cost for the first excluded nurse minus the cost of NMIs awarded), and the total value received by each nurse (their cash bonus plus the value of the NMIs awarded). The nurses receive a $30,000 greater value than with a monetary auction alone, totaling $230,000, because of the NMIs provided.

4. Valuing Combinations of Non-Monetary Incentives

Any retention auction that trades off a monetary incentive for multiple non-monetary incentives must recognize that the value of an NMI depends on what other NMIs are also provided. Much of the CRAM research to date has assumed a consistent independent additive effect for the value of NMIs; the value of any combination of NMIs is simply equal to the sum of the "stand-alone" values for those NMIs. However, this is not the likely case. If NMIs are complementary, their combined value may be super-additive (or greater than the sum of the individual values); if NMIs are substitutes, their combined value is likely sub-additive, or less than the sum of the individual NMI values (Ellis, 2009). As a result, this research distinguishes between purely additive NMI values and combinatorial NMI values, instances where the combined NMI values are not purely additive.

The disadvantage of combinatorial values is that it complicates the bid solicitation problem. If NMI values are not purely additive, the CRAM methodology described above must ask nurses to value the individual NMIs, as well as every possible NMI combination. With two NMIs, this requires four bids: cash only, each NMI in isolation, and the combination of two NMIs. As the number of NMIs increases, the number of bids required increases as 2^n, where n is the number of NMIs. If there are 10 NMIs, nurses would need to submit 1024 (2^{10}) bids. Resolving this issue under the current CRAM variant would require either limiting the NMIs offer to a small set, which would significant limit CRAM's potential advantages, or ignoring non-additive combinations of

NMI values. Ignoring combinatorial NMI values can either over-value the NMI combination awarded, causing some nurses to decline their retention incentive package, or under-value the NMI combination causing the Navy to over-pay for retaining their target nursing end-strength. This thesis explores an alternative CRAM methodology, the menu method described below, that helps address the combinatorial value problem.

5. CRAM Variants

To understand how the Combinatorial Retention Auction Mechanism works, it is important to first explain four CRAM variations, as each variation operates differently. The four CRAM variations are illustrated in Figure 13 and are classified based on two dimensions: (1) The NMI allocation method and (2) the price determination rule.

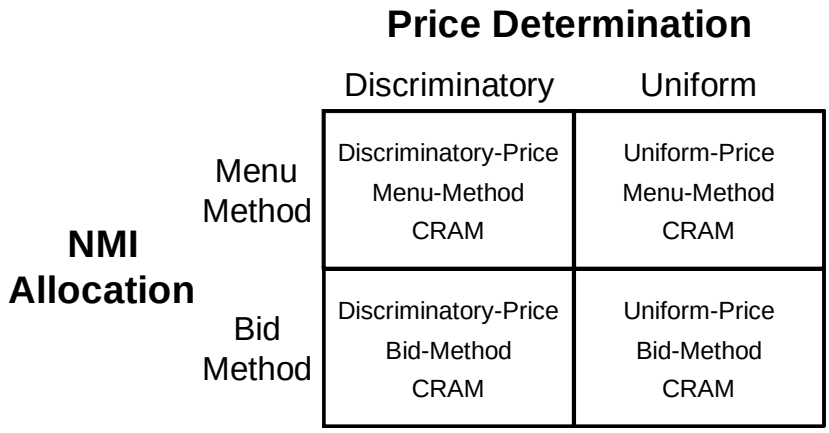

Figure 13. CRAM Variations

6. NMI Allocation: Menu Method vs. Bid Method

Under CRAM, NMIs can be allocated in one of two ways: the menu method or the bid method. Under the menu method, eligible nurse members are presented a list of the available NMIs, along with their associated Navy costs. Nurses would then select from this "menu" of NMIs and they will be granted any NMI selected, if retained. However, the Navy will include the combined cost of all NMIs selected as part of the cost to retain that nurse (see below). The nurse can select any combination of available NMIs, including none, one or all NMIs. Each nurse will maximize their net value by

determining the combination of NMIs that provides the greatest value relative to cost for them. Under the menu method, the nurse's monetary bid reflects the cash he/she requires, above any NMIs selected. Thus, the monetary bids submitted under the menu method are "post-NMI" cash incentive bids.

Under the bid method CRAM, nurses submit individual bids for each NMI offered, with the bid reflecting the cash bonus he/she would sacrifice to receive each particular NMI (if retained). The nurses would not be provided, *ex ante*, any costs associated with the NMIs, however they are granted any NMI for which they submit a bid greater than cost (if retained). As with the menu method, the Navy will include the combined cost of all NMIs allocated in calculating the cost to retain each nurse (see below).

Under the bid method, unlike the menu method, a nurse's bid for a monetary retention incentive reflects the cash amount he/she would require without receiving any NMIs. Without knowing NMI costs, the nurse would not know which NMIs he/she will be allocated when making the cash bid. The nurse's combined bids for all NMIs allocated are subtracted from this "cash-only" monetary bid to determine the "post-NMI" cash incentive bid. The "post-NMI" cash incentive bid plus the cost of NMIs awarded determines each nurse's total retention cost (see below).

The primary advantage of menu method CRAM is that it accommodates combinatorial NMI values as described previously. Nurses presumably have some idea of their value for the various combinations of NMIs; they can incorporate these combinatorial values into their NMI package selection, choosing the NMI package whose combined value exceeds the combined cost by the greatest amount (this is the optimal choice). The primary disadvantage of the menu method CRAM, on the other hand, is that the cost of providing each NMI must be reasonably well known, and published, in advance, which can be particularly problematic for those NMIs whose cost depends on the number of nurses choosing that particular NMI. The bid method advantages and disadvantages are the mirror image of the menu method advantage and disadvantages: the bid method does not incorporate combinatorial NMI values effectively; however, the cost of each NMI does not necessarily need to be known in advance.

7. Determining Winners: Total Retention Cost

After receiving all NMI selections or bids and all monetary incentive bids, the military service calculates the total retention cost for each service member. This cost is given by:

Total Retention Cost = "Post-NMI" Cash Incentive Bid + Total Cost of Allocated NMIs

The military service will then retain the set of lowest-total-cost service members. For example, if end-strength goals dictate that 2,000 service-members from a particular specialty in a particular grade must be retained in a particular year, then the military service will retain the 2,000 service-members among this group whose total retention costs are the 2,000 lowest costs. Each service member retained would then receive any NMIs allocated to him or her, as well as a cash bonus whose amount depends upon the pricing rule being used, as described in the next section.

8. Price Determination: Discriminatory vs. Uniform

The basic discriminatory-price and uniform-price auction rules were described in the early chapter on auction mechanisms. Under discriminatory-price CRAM variations, each retained nurse would receive the exact cash bonus requested; under the bid method, the nurse pays the amount bid for each NMI granted out of this bonus. Under the discriminatory-price CRAM, each retained nurse receives a cash bonus given by:

Cash Bonus = "Post-NMI" Cash Incentive Bid

Under a traditional uniform-price auction, all winning bidders pay or receive an amount equal to the first excluded bid. Under CRAM, each winning bidders receives a retention package (cash plus NMIs) whose total cost is equal to the first-excluded retention cost (the lowest total retention cost among those nurses <u>not</u> retained). Thus, under the uniform-price CRAM, each retained nurse receives a cash bonus given by:

Cash Bonus = First Excluded Total Retention Cost – Total Cost of Allocated NMIs

Under all CRAM variations, the nurses' total value includes the nurse's cash bonus plus the value of any allocated NMIs. If nurses have bid for NMIs wisely, their individual values should exceed the cost for all allocated NMIs. Thus, the total value received by each nurse will always be either equal to or greater than the actual cost to retain that nurse.

C. CHAPTER SUMMARY

In the uniform-price bid method, CRAM example described above, if the NNC planners wanted to retain two nurses, then nurse #1 and #3 would be the cost effective ones to retain. Each nurse would receive a package more valuable to them than the monetary incentives alone. CRAM is designed to be a "Win-Win" retention mechanism, which addresses the desires of the individual while keeping cost at a minimum. A portion of Zimmerman's research is included in the Appendix B of this thesis for a more detailed examination of CRAM. This research further investigates the discriminatory-price and menu method CRAM variants to see if individuals make rational decision under these different methodological variants and to compare outcomes across methodologies.

IV. EXPERIMENTAL DESIGN

A. BACKGROUND AND INTRODUCTION

1. Purpose of the Experiment

The purpose of the experiment, as well as the thesis itself, is to use an experimental approach to examine the decision-making behavior Navy Nurse Corps officers may demonstrate when making choices to stay in the Navy or separate from active duty. As discussed in previous chapters, NNC officers play significant value on certain monetary, as well as non-monetary incentives (NMI) when making retention decision. The NMI's that NNC officers find the most valuable have been outline in Chapter II. Based on the experiments, this thesis will examine whether subjects in an experimental environment will make retention decision that consistently reflect value to the subject is greater than cost to the "Firm."

If subjects in a controlled experimental environment consistently make decisions, where value is greater than cost then such an experiment holds promise for the Nurse Corps. A Menu Method or Bid Method CRAM could prove to be cost effective and efficient to the NNC and a substantially better value driven incentive package for the individual officer or targeted community. Dr. Peter Coughlan and Dr. William Gates have designed and administered a number of labor market experiments at the Naval Postgraduate School in Monterey, California with promising results for the use of auction mechanism in the DoD. This experimental research builds upon much their research while providing a window into the multiple opportunities for the use of auction mechanisms in the NNC, specifically the CRAM Menu Method and Bid Method.

2. Goal of the Experiment

The goals of the experiment is to examine whether subjects in the experiment faced with a retention decision, in a controlled environment, under uncertain employment conditions, will reveal certain expected truths. The most significant to this thesis is that

these individuals make choices in attempt to maximize their value, and in turn those retention decisions will reflect their value > cost to the firm. The results of such an experiment, along with subsequent research related to CRAM would be invaluable to NNC leadership when deliberating about the best means of evaluating and producing retention options for targeted communities. The value of cost to the NNC is the one of the obvious reasons to look at the use of CRAM; however, total cost to the NNC would include intrinsic cost or opportunity cost incur by officers throughout their careers. Additionally, this human factor is very difficult to measure or predict without experimental research. W. Norton states in his Master thesis from the Naval Postgraduate School, that "identifying intrinsic cost requires the DOD to study humans and human behavior. The primary reason to conduct experiments is because they capture this human element" (Norton, 2007). CA Holts says, predictions are often based on very subtle behavioral assumption for which there is little practical possibility of obtaining evidence from naturally occurring markets (Holts & Davis, 1993). In turn, this means that experiments are required to obtain such data.

B. TYPE OF ECONOMIC EXPERIMENTS

A large portion of the research methodology and detailed descriptions of labor economic theory, as well as experimental economics and experiment design comes from W. Norton, a research assistant and graduate of the Naval Postgraduate School. For detailed definitions and an in depth examination of experimental economics, a portion of his work can be viewed in Appendix G. However, some brief descriptions of basic economic theories may prove pertinent to this research, so they are reviewed in this section.

1. Market Theory

Market Experiment or Price Theory experiments are an early example of economist attempting to study a natural market. As mentioned in Norton's work, Edward Chamberlin was one of the early pioneers of labor market experiments (Norton, 2007). He was an economist during the late 1940s to early 1950s who began using laboratory

methods to study economics and test his market theories. He created a demand and cost structure in a simulated market by dealing his graduate students a deck of cards with cost and values on them, and essentially instructing them trade or sell between each. After running the experiment several times, Chamberlin was able draw some conclusions about the behavior of his student in this competitive, unregulated free market. He recorded the aggregate results and established a buyer's demand curve and sellers supply curve. He concluded that equilibrium is observed where these demand and supply curves or price and quantity intersect. His experiments with graduate students help form one of the first basic conceptual forms of experimental economic, which focuses on the trade-off between value or and cost. Figure 14 illustrates Chamberlin supply and demand curves.

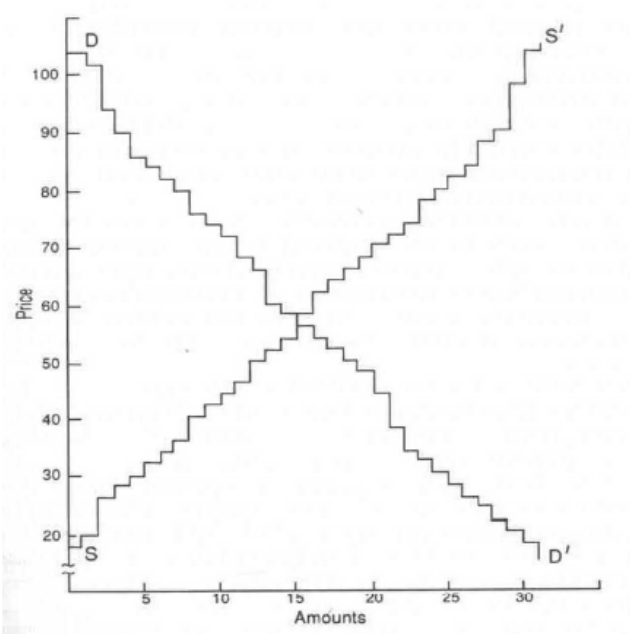

Figure 14. Induce Supply and Demand Curves (From: Chamberlin, 1948)

2. Game Theory

Game theory attempts to mathematically capture behavior in strategic situations, in which an individual's success in making choices depends on the choices of others (Game Theory, 2010). It has become a mainstay in economic theory and experimental

economics at most business school throughout the country. Game theory can actually be traced back as early as the 1920s when researchers began to develop the economic model as a unique and extensive field of study. Game theory is used to describe the interaction of rational agents under precisely specified information and action conditions (Holts & Davis, 1993). “The Prison’s Dilemma” or “Two Dilemma” is an early and precise illustration of the basic concepts of Game Theory.

The example used in Figure 15 depicts two people, Prisoner A and Prisoner B, who are faced with a dilemma. The local police have arrested both individuals on suspicion of perpetrated a serious crime. Each prisoner is locked in an interrogation room, being intensely interviewed by the police. The police give both prisons the option to implicate the other in the crime and receive a lighter sentence. If Prison A (PA) implicates Prison B (PB) in the crime, and PB remains silent, then PA will receive NO time in prison, while PB receives 10 years. If the opposite occurs and PB implicates PA, and PA remains silent then PB receives no jail time, while PA is sentence to 10 years. If neither of the prisons decides to speak with the police, they will each serve two years. However, if both Prisons implicate each other, they both will serve five years in prison. The decision matrix demonstrates how both PA and PB would be better off if they both remained silent. However, they are isolated and neither is aware of what the other will do or the incentives they are being offered. Therefore, if each prison desires to maximize their pay off or ability to be free, then both would be better off implicating the other.

	Prisoner B Stays Silent	**Prisoner B Betrays**
Prisoner A Stays Silent	Each serves 2 years (2, 2)	Prisoner A: 10 years Prisoner B: goes free (10, 0)
Prisoner A Betrays	Prisoner A: goes free Prisoner B: 10 years (0, 10)	Each serves 4 years (4, 4)

Figure 15. The Prison's Dilemma Example (From: Game Theory, Wikipedia, 2010)

3. Individual Decision Theory

The individual decision theory involves attempting to quantify the behavior of individuals making decisions or choices relevant to their personal utility with uncertain conditions. According to the Encyclopedia Britannica, a detailed explanation for this theory in statistics, it is a set of quantitative methods for reaching optimal decisions. A solvable decision problem must be capable of being tightly formulated in terms of initial conditions and choices or courses of action, with their consequences (Decision Theory, 2010). In general, such consequences are not known with certainty but are expressed as a set of probabilistic outcomes. Each outcome is assigned a "utility" value based on the preferences of the decision maker. An optimal decision, following the logic of the theory, is one that maximizes the expected utility (Decision Theory, 2010). Individual Decision Theory is most relevant to Menu Method CRAM and Bid Method CRAM experiments conducted for this thesis. Each process involves individuals making a decision about their overall compensation, face with the uncertainty of the auction process.

C. EXPERIMENT PURPOSE

The experiment tested whether an individual would bid rationally when facing decisions involving a cash salary and interdependent combinations of two NMIs. Experimental subjects are one of a hundred employees at Firm A choosing whether to continue employment at Firm A; each participant compete against 99 simulated Firm A employees. In the scenario, Firm A is downsizing by 50 percent. Another generic company, Firm B, has offered to employ all former employees from Firm A, representing the participant's opportunity cost of employment at firm A. This is what the bidder could earn if they left Firm A. Subjects have no preference for either firm and are only interested in maximizing their personal compensation, including cash salary and the value of any NMIs awarded. Experimental subjects submit a salary request to Firm A and either select a package of NMIs (menu method CRAM) or bid on alternative combinations of NMIs (bid method CRAM). Firm A retains the 50 lowest cost employees. Experimental subjects are compensated based on the total value of their compensation (cash and NMI value) in each round. The experiment was designed without a military context to remove bias. The decisions presented were identical to what a service member would experience in making their retention decision.

The experiment involves 30 trials and is broken into three treatments, (10) purely monetary, (10) independent NMIs (additive values), and (10) combinatorial NMIs (with potentially sub-additive or super-additive values). The trials are conducted in a pyramid style, as shown in Table 6. The pyramid style gradually introduces complexity into the process and identifies learning effects by later eliminating the complexity. The experiments were conducted using both the discriminatory and uniform price auction mechanism and compare the menu and bid method alternatives. This thesis will only report the discriminatory price auction results.

Experiment Structure	
Rounds 1 – 5:	Monetary Only
Rounds 6 – 10:	Independent NMIs
Rounds 11 – 20:	Combinatorial NMIs
Rounds 21 – 25:	Independent NMIs
Rounds 26 – 30:	Monetary Only

Table 6. Experiment Structure

CRAM requires individuals to understand the value they receive from various combinations of NMIs; it is important to evaluate if bidders make the correct selection while facing super- and sub-additive NMIs. Inefficient decisions may cause separation and retention errors. For example, consider the case where NMIs are super-additive. The individual could want and could have been retained if the values of NMIs were properly calculated. If super additive values are not properly considered, this represents an inefficient separation; the individual could be separated when they should have been retained. Conversely, suppose values are sub-additive. If not properly considered, the bidder could be offered retention but would be better off at firm B.

D. OPTIMAL BIDDING STRATEGY: DISCRIMINATORY AUCTION

Recall that a discriminatory auction is a first-price auction. In the experiment, those who submit the 50 lowest total cost bids are retained by Firm A and are paid the salary they each individually requested, assuming no NMIs are offered; those who submit the 50 highest total cost bids are laid off from Firm A and immediately work for Firm B at the amount previously offered.

The subject must look at Firm B's offer, which becomes the subject's reservation wage, and then enter a salary request to Firm A. As previously discussed, if an individual was to bid truthfully in a discriminatory auction, he or she would not maximize their expected surplus value. Therefore, the optimal bidding strategy is to look at Firm B's

offer and bid higher in relation to the expected range of offers. The bidders should estimate the first excluded bid, based on their perception of the range of opportunity costs, and bid just below the expected cut-off. If they are risk averse, they might shave their bid a bit to reduce the risk they face. After making the cash bid, the subject must incorporate the value of the NMIs offered. Bidders know their NMI value. In the bid method CRAM, bidders should deduct the true value of their NMIs from the cash bid; in the menu method CRAM, bidders should always take the cash only salary request and subtract the value of the selected NMIs. This adjusted cash value is the optimal bid in the menu method CRAM.

E. EXPERIMENT LAYOUT AND DESIGN

Now, that the auction mechanism process, CRAM, and experimental economics have been thoroughly reviewed, this area of the thesis will re-construct the actual experiment. The details of the layout and design of the Menu Method CRAM and Bid Method CRAM experiments conducted for this research are explained here. The experiments followed a consistent theoretical model of experimental economics based on previous research by Dr. Coughlan and Dr. Gates. The labor market experiment conducted for this thesis and on-going research complied with common, accepted quality control measures for labor market experiments. The outline of this section will follow a logical pattern based on the those measures of quaility. Davis and Holt originally classified the following procedural and design considerations for conducting labor market experiments in a laboratory (Norton, 2007). The concepts are *Replicability, Control*, *Procedural Regularity*, *Motivation, Unbiasedness*, *Calibration, and Design Parellelism.*

1. Replicability and Control

The primary advantage of conducting these experiments in this setting is that the laboratory environment offers the experimenters a degree of replicability and control. The experiment has been carefully designed by experienced experimenters and precisely documented, which allows for replication of the experiments conducted and independent examination of the results. Control is the capacity to manipulate the laboratory conditions

so that observed behavior can be used to evaluate alternative theories and policies (Holts & Davis, 1993). Unlike the natural markets, which have variations in the production and collection of data for evaluating alternative theories, in the laboratory setting the collection of distinguishing, relevant data is acheived due to the experimenters ability to set controls. In the experiments conducted for this research, control were established based on the experimenters and protors ability to control which questions are pertinent to the research, evaluation of possible inputs that may effect the data, strict control on access to data, and continual observance and control of subjects throughout the experiment.

2. Procedural Regularity

Procedural regularity focuses on the ability for the independent verification and the experiementer's data collection methodology and ability to effectively report the results (Norton, 2007). In order to establish procedural regularity, this section will include the specific instructions given to the subjects, the make up or demographics of the subjects in the study, and the instructions given during the "trial" period or practice rounds, where no reward was given at that time. It is important that the experiment followed procedural norms, is created a laboratory setting that is replicable and controlled, and established professional credibility for further research and development in the field of auction mechanisms.

The subjects were drawn from the student and staff population at the Naval Postgraduate School in Monterey, California. A general email annoucement was produced and distributed, campus-wide to solicit volunteers for the experiment. An example of the message can be viewed in Figure 16. The message did not include specifics, or expose the exact details of the experiment, to avoid creating any preconceived notions, unrealistic expectations, or biased responses during the experiment.

REQUEST FOR PAID VOLUNTEERS

Fellow NPS Students,
I am seeking paid volunteers to participate in a decision making experiment. The experiment is in support of a thesis.

- What: Participants will use a computer and input responses based on information provided. --- Detailed instructions will be given and it will be conducted in a stress-free environment. The total experiment will take less than 2 hours. Volunteers will get paid based on decisions made during the experiment; average earnings will be between $20-$30.
Please select one of the following four times listed below:
- When: March 2 (Tues) @ 1230 or 1500, March 3 (Wed) @ 1000 or 1500
- Where: NPS, Ingersoll computer lab (Ing-224)
- Who: Open to all NPS Students **(except those who have previously participated)**
- Why: To assist a fellow student with research and GET PAID!
- How: If you are interested, please email me (mhlevy@nps.edu). Tell me what times you prefer and provide a 1st and 2nd choice in case a session becomes filled. I will respond to you, confirming your participation and time.
Thank you for your time.

Figure 16. Request for Experimental Volunteers

The computer generated experimental Menu Method CRAM and Bid Method CRAM tested a total of 50 subjects over a three day period, in a total of four sessions. The experiment was lead by Dr. Peter Coughlan and LT. Marlow Levy, Dr. William Gates, Dr. Noah Myung, and Capt. Kyle Hahn assisted as proctors. Each session consisted of 30 periods, or rounds, with specific and detailed instructions and adequate time for questions. The subjects were identified, confirmed, and assigned random computers throughout the lab as they entered the lab. Each subject, as they settled in their prospective seats began a simple on-line registration process.

Additionally, they were instructed to sign a privacy and confidential statement before any other experimental procedures could proceed. Each participant signed and turned-in their original consent forms to a proctor or experimentor. An example of this form can be seen in the Appendix J. The initial instructions were provide and the scenario listed in Appendix A was introduced. New instructions with minor changes to the scenario were given after the 5th period, 10th period, 20th period, and 25th period. The average "Years of Service" (YOS) for the subjects was 11 years. There were 48 males and two female participants. The majority of the particpants in the study were active duty

Navy Officers, as seen in Figure 17, with 24 members represented. The individual YOS and data related to rank and gender can be viewed in Figure 17 Experimental Demographics.

	YOS Total Avg			
	Session 2 - 3/2/2010@1500			10.08
	Session 3 - 3/3/2010@1500			12.75
	Session 4 - 3/4/2010@1300			7.875
	Session 1 - 3/2/2010@1230			11.92
	Total All Sessions			11.06

Session	1	2	3	4	Total
O-1	0	0	0	1	1
O-2	1	1	1	0	3
O-3	3	4	7	5	19
O-4	9	5	7	1	22
0-5	0	1	1	1	3
E-5	0	1	0	0	1
CIV	0	1	0	0	1
Total	13	13	16	8	50
Males	13	12	16	7	48
Females	0	1	0	1	2
Total	13	13	16	8	50
USN	5	6	8	5	24
USA	1	2	3	0	6
USAF	6	0	2	1	9
USMC	0	1	3	0	4
FORN	1	3	0	2	6
CIV	0	1	0	0	1
Totals	13	13	16	8	50

Figure 17. Demographics of the Experimental Subjects

One of the most important elements of the experiment is the instructions given to the subjects in the beginning of the experiment, as an introduction, and each subsequent set of instructions throughout the experiement. The instructions allowed the proctors and experimentors to lay out the details of the instruction, set the control conditions, set up the natural market scenario, establish understanding of the instructions and process,

clarify important details, address questions and concerns, and adjust for new experimental treatments throughout the process. The complete set of instructions for each round is included in Appendix A. Figure 18 is a sample of the registration form.

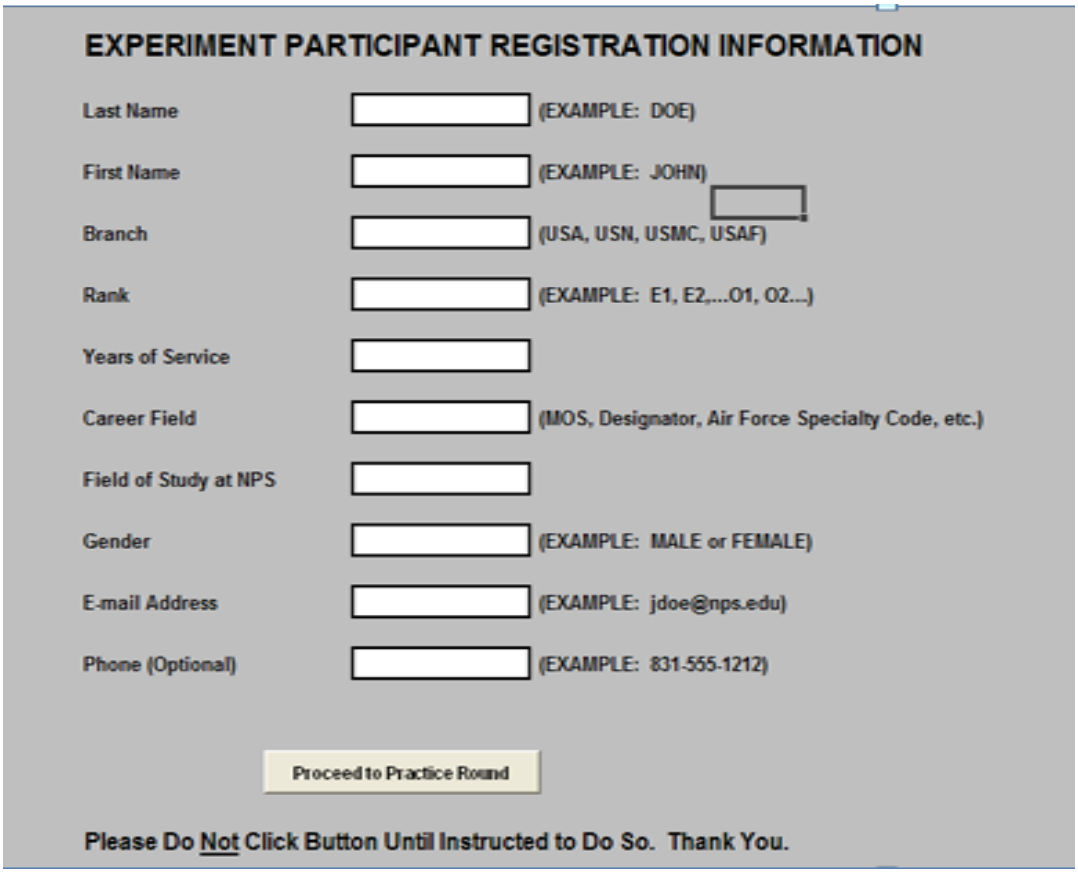

Figure 18. CRAM Experiment Registration Form

Subjects were particiapting in a labor market research experiment and ask to make salary decisions based on the given scenario:

3. Scenario Background

You are one of 100 employees currently working for Firm A. Your only other potential employer is Firm B. You have no particular preference for Firm A or for Firm B. You can easily switch employers at no cost or inconvenience to you. Your only goal is to maximize the value of your annual compensation.

- **Downsizing at Firm A**
  - Firm A will be downsizing, and 50 of its 100 employees be will be laid off immediately.
  - After these one-time layoffs, however, employees will have the same level of job security at Firm A as at Firm B.
- **Employment Offer from Firm B**
  - Firm B has offered to employ anybody who leaves Firm A. If you leave Firm A now, you will work at Firm B immediately. This standing offer of employment at Firm B applies whether you leave Firm A voluntarily or are laid off.
- **Salary Offer from Firm B**
  - Firm B has presented a confidential annual salary offer to each employee currently working for Firm A. The offer presented to each employee represents the annual salary that he/she will receive if employed by Firm B. Firm B has offered different annual salary amounts to different Firm A employees. Firm B has offered to pay you the following annual salary: $ 172,000
- **Distribution of Salary Offers from Firm B**
  - You do <u>not</u> know the salary amounts that Firm B has offered to other current employees at Firm A. You know only that all of Firm B's salary offers are spread evenly over some range.
  - In other words, these salary offers are spread evenly between some lower bound & some upper bound. You do not know the actual lower and upper bounds of the range of salary offers.
  - However, you do know that the salary offered to you by Firm B lies somewhere within this range of offers. Thus, it likely that some of Firm B's salary offers to potential employees are higher than your offer above. It is also likely that some of Firm B's salary offers to potential employees are lower than your offer.
- **Salary Survey at Firm A**
  - The salary paid to any Firm A employee in previous years will have no influence on his/her future salary at Firm A. Instead, the annual salary that Firm A will pay to each of its retained employees will be determined using a survey. Firm A is asking each of its 100 workers to specify the minimum annual salary that he/she would need to receive in order to remain with Firm A.
  - Firm A will then retain the 50 of its 100 employees who submitted the 50 lowest salary requests. In other words, after collecting all 100 “salary requests” from its employees, Firm A will lay off the

50 employees who submitted the 50 highest salary requests. Each of the 50 employees laid off will immediately begin working at Firm B at the salary previously offered.

- The remaining 50 employees will work at Firm A. All employees retained by Firm A will be paid the same salary, regardless of the salary they requested. These retained employees will be paid the lowest salary that was requested among the 50 employees laid off. In other words, Firm A will pay all retained employees the 50th highest salary requested. Note that this salary will be as high or higher than the salary requested by any of the 50 retained employees.

- **Your Salary Request to Firm A**
  - You must now decide what annual salary to request from Firm A. Remember that if your request is among the highest 50 of the 100 salary requests submitted, you will be laid off from Firm A and will work for Firm B. If your salary request to Firm A is among the 50 lowest requests, you will continue to work for Firm A and will receive an annual salary equal to the lowest salary requested among the 50 employees not retained.

Table 7 served as a graphical representation of the written instructions provided to subjects. It further explained the scenario and the selection process, called a survey, utilize in Firm A's decision process. Subjects were presented with multiple means of instruction to firmly establish they understand the instructions and clarify any misinformation or misinterpretation. Additionally, Figure 19 depicts the Practice Results sheet when a subject has completed their evaluation, submitted a bid, and Firm A has made its retention decisions. The subject was found to be one of the lowest bidders and therefore retained by Firm A.

Salary Survey to Determine Employer and Salary

Employee Number	Salary Request	Future Employer	Annual Salary
1	$150,000	Firm B	Firm B Offer
2	$149,000	Firm B	Firm B Offer
3	$148,000	Firm B	Firm B Offer
4	$147,000	Firm B	Firm B Offer
5	$146,000	Firm B	Firm B Offer
⋮	⋮	⋮	⋮
48	$103,000	Firm B	Firm B Offer
49	$102,000	Firm B	Firm B Offer
50	$101,000	Firm B	Firm B Offer
51	$100,000	Firm A	$100,000
52	$99,000	Firm A	$99,000
53	$98,000	Firm A	$98,000
⋮	⋮	⋮	⋮
97	$54,000	Firm A	$54,000
98	$53,000	Firm A	$53,000
99	$52,000	Firm A	$52,000
100	$51,000	Firm A	$51,000

Table 7. Sample of Salary Survey to Determine Employer and Salary (From: Coughlan, 2010)

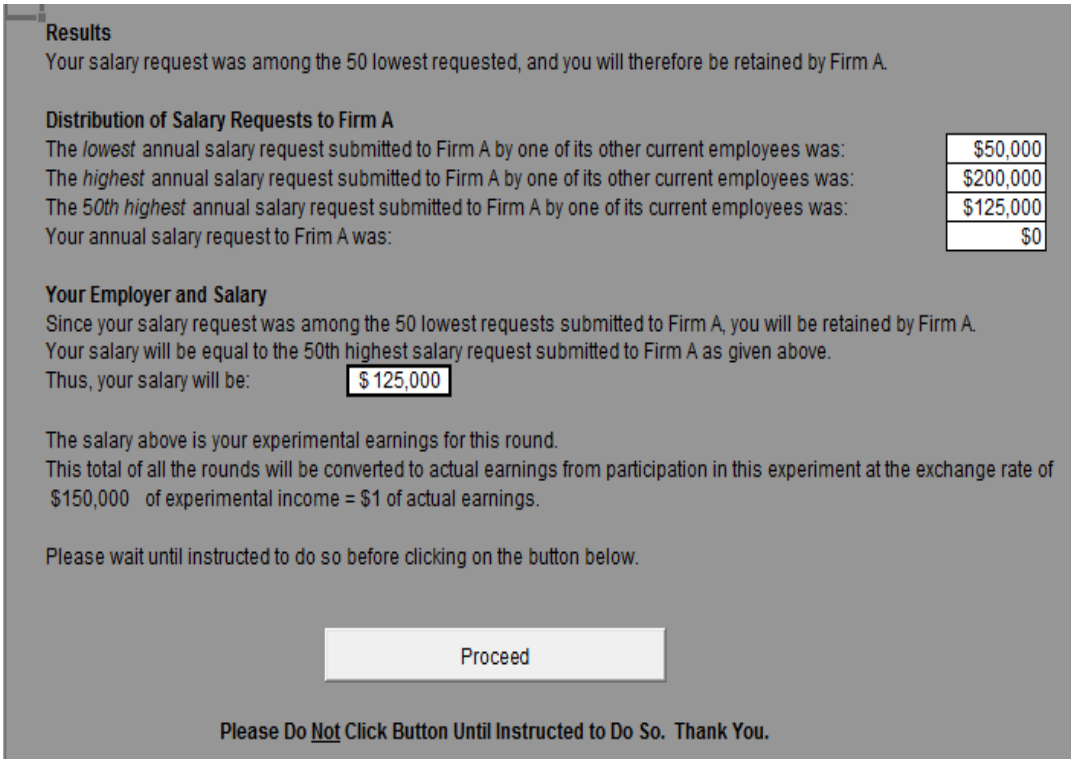

Figure 19. Results for Menu Method CRAM Bid (Firm A)

Figure 20 depicts the Practice Results sheet when a subject has completed their evaluation, submitted a bid, and Firm A has made its decision to lay off the employee. Therefore, the subject was one of the highest bidders and was separated to Firm B.

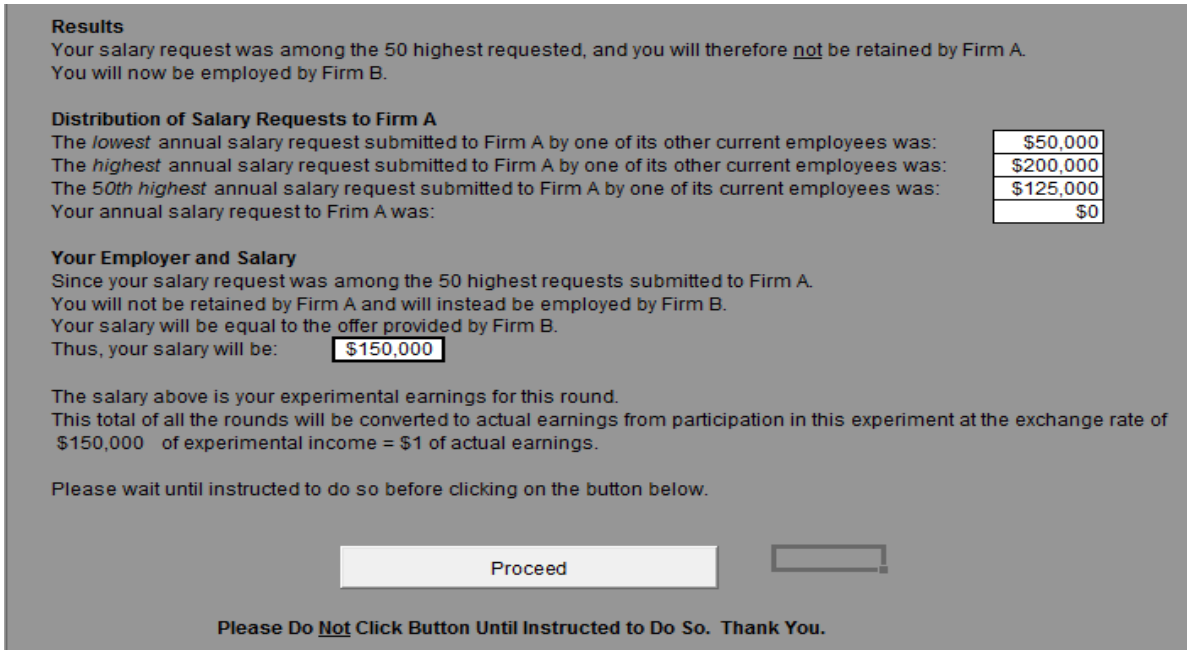

Figure 20. Results for Menu Method CRAM Bid (Firm B)

4. Motivation

The motivation or reward for particpiating in the experiment was clearly explained to the subjects in the experiment. Their "salary" upon completing the experiement was explained in the instructions. A depiction of the the pay-out form is included in this section to further illustrate the tools used in the experiment to motivate the subjects. Holts noted, "failing to use salient financial rewards is a critical error" (Holts & Davis, 1993). Figure 21 demonstrates the summary page with each subject's results, experiemental earnings, and actual earnings. The subjects were paid in separate area to provide security and privacy. Each subject provided the experimentor with a signed copy of the summary as a pay-out record .

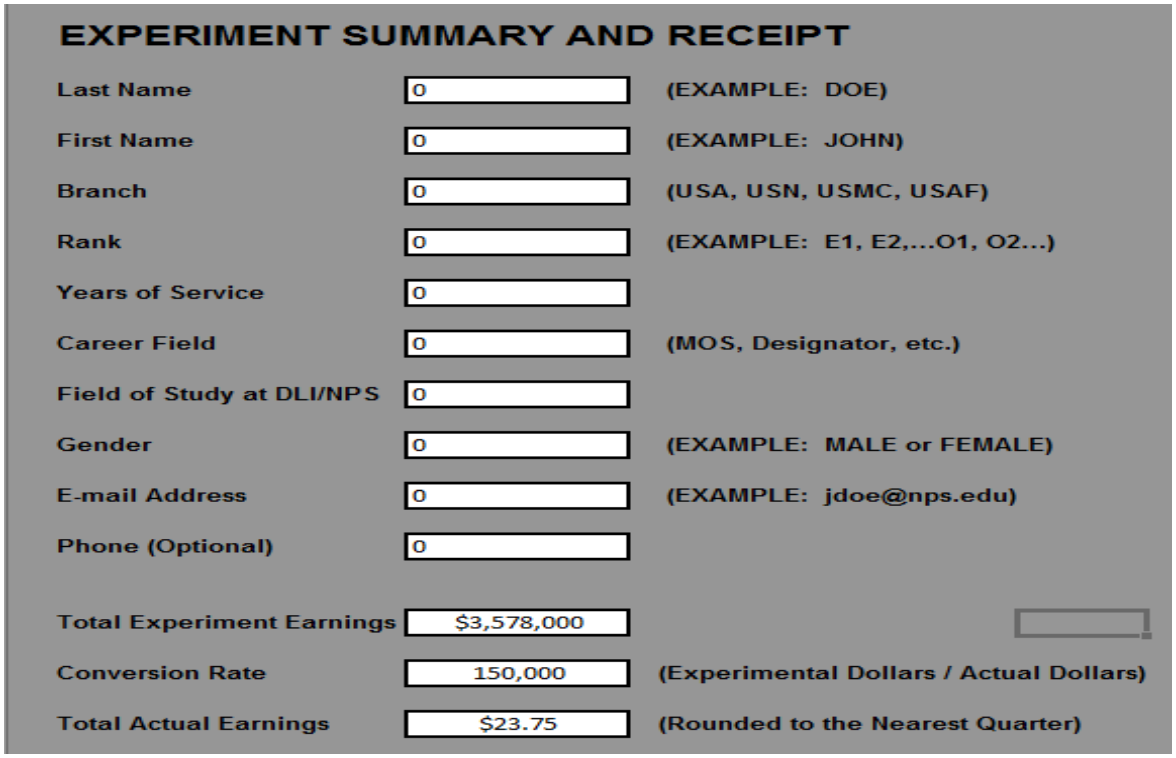

Figure 21. Example of Experiment Summary and Receipt Sheet

5. Unbiasedness, Calibration and Design Parellelism

The standard of calibration which states the experiment should set a baseline and the choices should be clearly delineated and understood (Holts & Davis, 1993). The calibration in the experiment is set from the beginning of each session in the instructions. Unbiasedness refers to an experiment that does not lead the subjects to perceive that any particular behavioral pattern as being expected or correct. The subjects in the experiment were givien few details about the actual experiment until they were in the lab under controlled conditions. Within the initial instructions they were advised that their decisions did not affect the other participants and they had no preference for a particular employer in the scenario. Therefore, subjects received no guidance on what to bid or had any motivation to compete with other subjects in the lab. Design Parellelism suggest that an experiment be constructed to resemble naturally occuring economic situations (Norton, 2007). In this experiment, the scenario relates directly to a common occurrence at firm

throughout the country on a daily and personal basis. The data gathered from this experiment can be directly associated with naturally occurring economic phenomena, specifically retention in the U.S. Navy Nurse Corps.

F. CHAPTER SUMMARY

The overall scenario in this research is that subjects are participating in a laboratory controlled experiment that mimics a real life labor market economic condition. The purpose, instructions and procedures are extremely important when designing and ultimately conducting labor market experiments. According to C. R. Plott, the instructions and procedures are of central importance to laboratory experimental methods (Plott, 2001). Not only are they important to the current experiment, they are important to all concurrent experiments on related topics, in addition to all future experiments (Plott, 2001). Therefore, the purpose, instructions and procedures were the focus of Chapter IV. Appendix H. contains a section from Plott's experimental design text on the importance proper instructions and layout when conducting labor market experiments.

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V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

A. ANALYSIS

The analysis gathered from the four experimental sessions revealed very little surprises when it come to the performance and efficiency of CRAM as a retention auction tool. However, there were some surprises as to the behavior of the participants and their performance when faced with complex decisions. As previously mentioned, there were 4 sessions, over a 3-day period with 30 rounds or periods per session. On Day 1, the experimental Uniform and Discriminatory Menu Method CRAM was conducted during 2 sessions. On Day 2, the experimental Discriminatory Bid Method CRAM was conducted on one session. Finally, on Day 3, the experimental Discriminatory Bid Method CRAM was conducted on one session. During the sessions themselves, the periods 1–5 and 26–30 consist of Cash Only bids, periods 6–10 and 21–25 consist of Cash and NMI bids with additive effects, and periods 11–15 and 16–20 consist of the combinatorial discriminatory bids. The results reported here include the three discriminatory price rounds; these are combined with two sets of discriminatory price menu method CRAM experiments conducted by Captain Kyle Hahn for his Master's thesis (being published concurrently) (Hahn, 2010).

1. Cash-Only Salary Request Comparison Ratios

Remember, in the uniform price auction, the bidder receives the salary of the first-excluded offer. Therefore, everyone receives compensation with the same cost to the employer. The expected strategy is that subjects should bid their true value. Their bid does not affect the cost of their compensation package from Firm A, just whether they are retained. If subjects bid above their opportunity cost, they may be laid off and employed by Firm B, where the salary is already known and may be below the salary paid by Firm A. If they bid too low, they could be retained by Firm A, yet not receive a high enough salary to meet the foregone guaranteed salary offered by Firm B.

As described above, the bidding strategy is more complicated for discriminatory price auctions, such as those reported here. Subjects should estimate the first excluded bid and bid just below that amount. Assuming the opportunity costs (Firm B offers) for the other bidders are probabilistic and uniformly distributed over some range, the equilibrium bidding strategy in a discriminatory price auction is to assume you are the medium value amongst the least cost participants (those that would be retained if bids were truthful). With Firm A retaining 50% of its employees, if subjects knew the upper bound of the Firm B offers, they should bid a Cash Only price to Firm A that is one third of the difference between their value and the upper bound Firm B offer. This is the "optimal" cash bid reported here for the discriminatory price auction.

Only the discriminatory price auctions are discussed here, so one would expect participants to bid above their opportunity cost and closer to the optimal bid described above. The Cash Only bid participants submitted in both the discriminatory Menu and Bid Method CRAM sessions was very close to the optimal cash bid, the ***average request across all rounds was exactly 100% of the optimal bid (one third of the difference between the bidders opportunity cost and the upper-bound Firm B offer), with a standard deviation of .22***. It simply means on average the subjects were bidding at their optimal value or close to it, when it comes to the Cash Only salary request surveys. The results of the experiment show subjects were bidding 5% above their optimal value in rounds 1–5. However, in the later "Cash Only" bid rounds of 26–30, they were much closer to the optimal value; they requested 98% of the optimal valued bid request. It indicates that subjects were increasing their ability to interpret their opportunity cost and bid appropriately. Rather than continuing to bid too high, and increase their bidder surplus but risk being separated, they return to some value equilibrium point, close to their optimal bid. It was similar in all other rounds also, subject seem to adjust their bidding strategy for the cash only bids in the later rounds, to move closer to the optimal salary request. When looking at the Cash plus NMI's with additive effects, periods 6–10 and 21–25, the subjects maintain a 2% average below and above the optimal salary request, respectively. The subjects in combinatorial discriminatory periods (rounds 11–15 and 16–20) were relatively consistent in all those periods at 98% of the optimal bid. For

reference, Figure 22 also shows the relationship between the actual cash bid and the bidders' opportunity cost. As expected with optimal discriminatory bids, the actual bids exceed opportunity cost by approximately 15 percent.

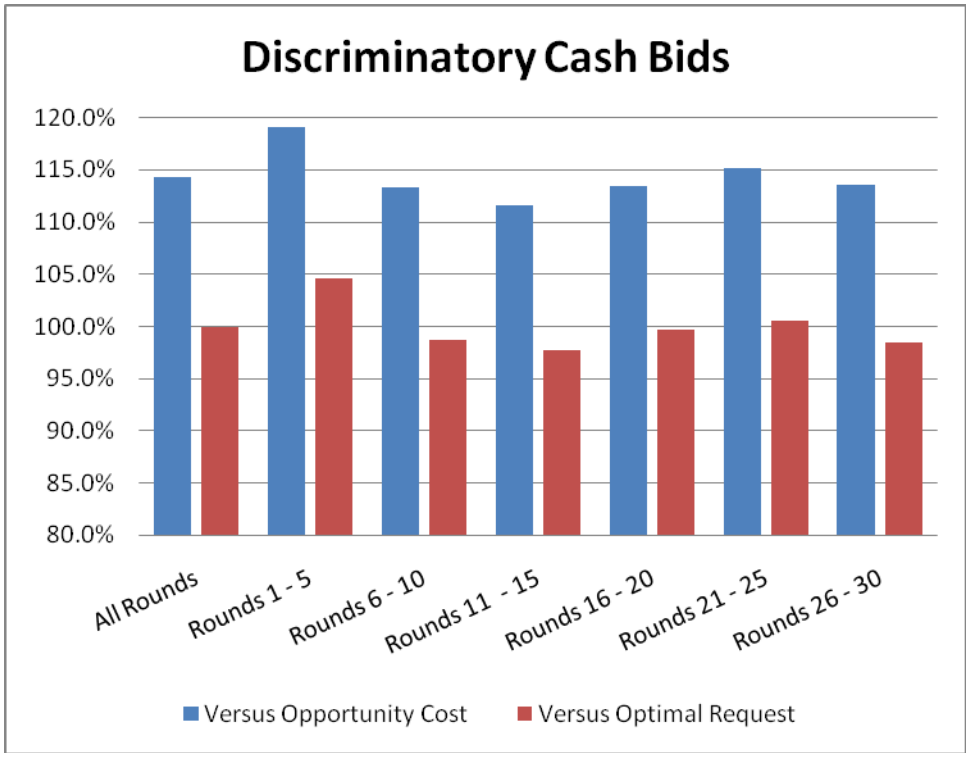

Figure 22. Discriminatory Cash Bids Optimal Request vs. Opportunity Cost

In Figure 23, we see the Post NMI salary request vs. the optimal value and opportunity cost. In the Menu Method CRAM, bidders select their NMI package and submit a cash salary request understanding that the cost of the NMIs selected will be added to their salary request to determine their cost to retain; if retained, they will receive all NMIs selected. In the Menu Method CRAM, bidders should reduce their cash only optimal salry bid by the cost of any NMI selected. Figure 25 shows the Cash Only salary requests both with and without NMIs. Rounds 1–5 and 26–30, so these values represent purely cash salary requests. Figure 23 shows that these requests are about 5% above optimal in rounds 1–5 and slightly below the optimal in rounds 26–30. The data further show that bidders seem to have reduced their salary requests more than optimal in the

first five rounds with additive NMI values (rounds 6–10) and with combinatorial NMI values (rounds 11–15); the cash salary request moves closer to the optimal level in the later combinatorial and additive NMI rounds (rounds 16–20 and 21–25). After allocation of the NMI's, the results of the surveys did not change for the Menu Method CRAM or Bid Method CRAM. The average remained at 100%, and all rounds were identical to the value maximizing percentage seen with the Cash Only bids. In all rounds, subjects were continuing to bid the optimal value and reservation wage.

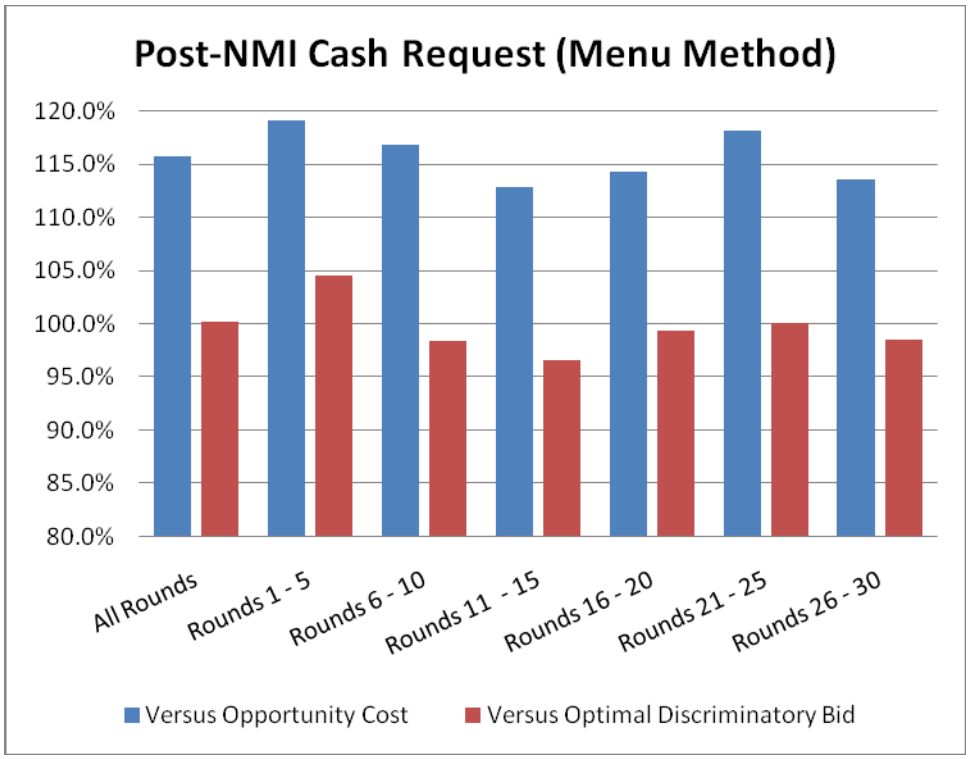

Figure 23. Menu Method Post NMI Request Optimal Bid vs. Opportunity Cost

2. NMI Bids True Value vs. Optimal Value

When including NMIs in the discriminatory price auction, the equilibrium bidding strategy in the CRAM menu method can be characterized as selecting any NMI for which your value exceeds your cost and adjusting your cash request by the NMI costs. In the CRAM bid method, your cash bid cannot anticipate that you will be granted any NMIs

because you do not know if the NMI value you bid is greater than cost. Therefore, you want to understate your true NMI value in a discriminatory price auction; the more you understate your value the greater your surplus if you receive the NMI, but the lower the probability of receiving the NMI. The equilibrium strategy is to bid five-eighths (62.5%) of your NMI value for individual NMIs or additive combinations. There is a similar, but more complicated relationship for NMI packages with combinatorial values. These NMI bidding strategies for the Menu Method and Bid Method CRAM will be referred to as the "optimal" bidding strategies in this discussion.

Figure 24 shows that on average subjects bid 76.8% of their true NMI value for NMI 1 bid, and 73.7% of value when they bid for NMI 2. When comparing the "Cash plus NMI with additive effect" rounds of 6–10 and 21–25, we note a slight increase in the bids for NMI1 and NMI2; their bid for NM1 was 78.9% and NMI2 80.7% of their reservation wage. There is a slight decrease as the subjects bid in the Combinatorial Discriminatory rounds, from 11–15 to 16–20. In rounds 11–15, subjects bid below their value for NMI1 at 74.7% and NMI2 at 69.4 percent. In rounds 16–20, they bid at 72.9% of their value for NMI1 and 67.7% for NMI2. Thus, participants consistently under bid their NMI values, introducing the possibility that they would leave "money on the table" by not receiving NMIs for which their value exceeded the cost. These bids were higher than the equilibrium, full-information strategy, which could reflect risk-aversion (increasing bids to increase the probability of receiving the NMI but reducing the profit if awarded) or some other factor.

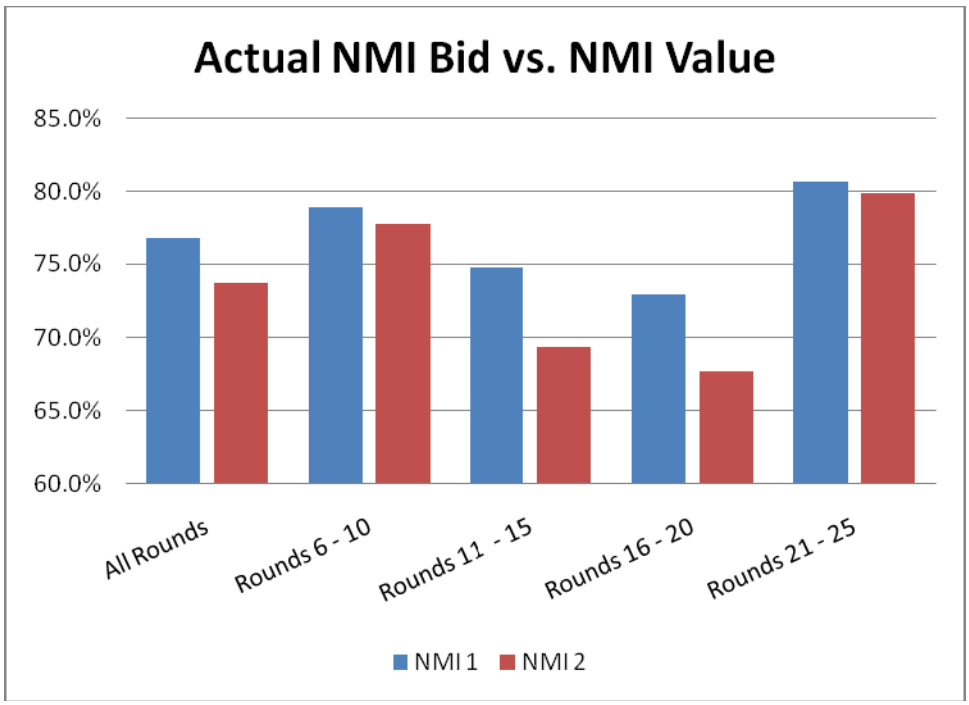

Figure 24. Comparing Non-Monetary Incentive True Values

In the discriminatory Bid Method CRAM, the subject consistently bid above their optimal value. As noted in Figure 25, if the optimal bid is 100%, subjects bid 46% above the optimal bid in all Bid Method CRAM rounds. In the Cash plus NMIs with additive effect rounds, we see a slight increase in their bidding pattern. Subjects were bidding 26.2% above the optimal value for NMI1 and 24.4% above, in rounds 6–10. The pattern continues in the later rounds 21–25. The subjects bid 29.1% above their optimal value for NMI1 in rounds 21–25, and 27.8% above their value for NMI2 of the same round. In the combinatorial discriminatory rounds 11–15 and 16–20, subjects also bid above their optimal value. In rounds 11–15, subjects bid 59.4% above their value for NMI 1 and 48% for NMI2. In addittion, subjects bid 55.6% and 44.4% above their optimal value for NMI1 and NMI2, respectively.

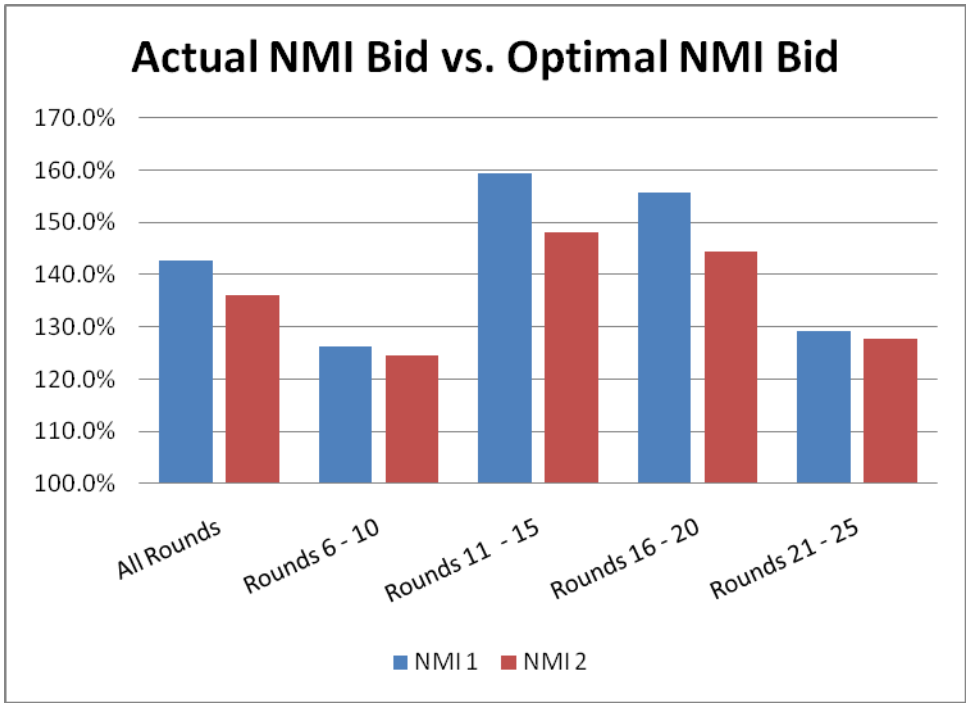

Figure 25. Comparing Non-Monetary Incentive Optimal Value

3. NMI Allocation Efficiency

The experiments yielded some interesting results related to efficiency of NMI allocation. This addresses whether the subjects selected the NMIs that maximized their value over cost. If efficient allocation is the base line at one, meaning one indicates an efficient NMI allocation, then any value less than one indicates the fraction of participants selecting the efficient combination of NMIs. If every participant receives the efficient NMI allocation, the associated "Dead Weight Loss" should be equal to 0; where dead weight loss is the surplus value lost by an inefficient NMI allocation; dead weight loss greater than zero indicates the relative magnitude the efficiency loss.

The results in Figure 26 show that 55% of the participants select the efficient NMIs over all rounds involving NMIs. The percentages of efficient selections are higher in the rounds involving additive NMI values (6–10 and 21–25) as opposed to the combinatorial NMI value rounds (11–15 and 16–20). The data also shows a strong

learning effect, with the percentage of efficient NMI allocations increasing from the early additive and combinatorial rounds to the later rounds. The average deadweight loss per participant shows similar patterns, as reflected in Figure 27.

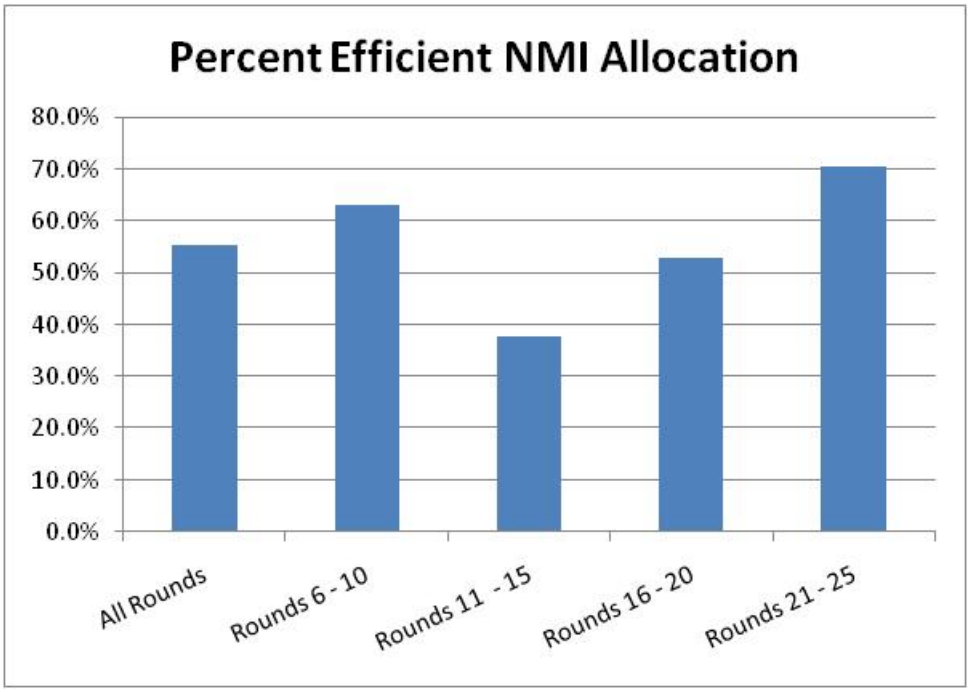

Figure 26. Percent Efficient NMI Allocation

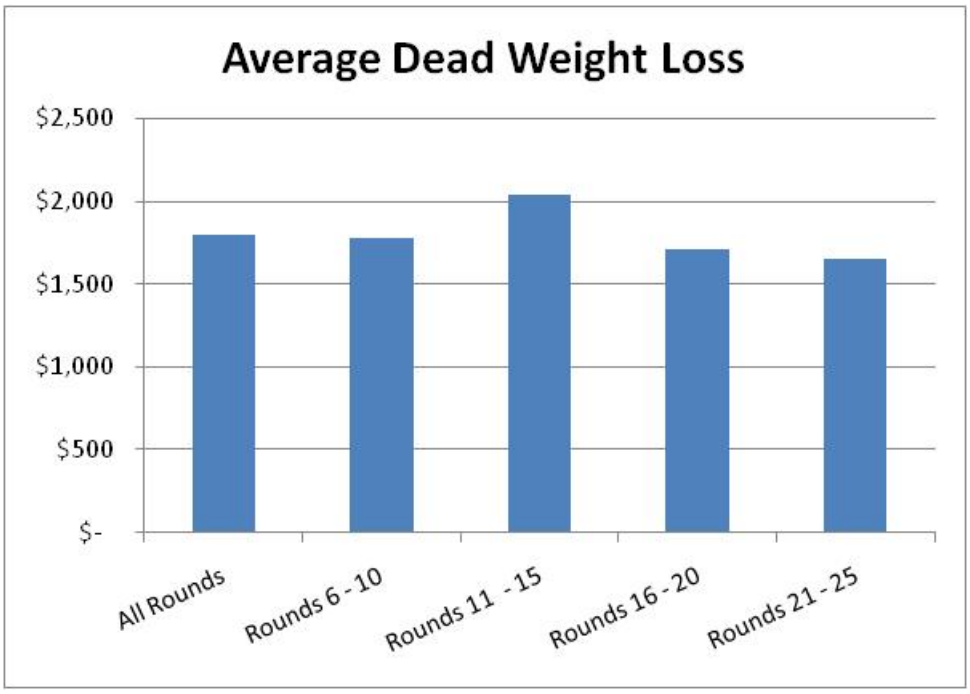

Figure 27. Dead Weight Loss per Participant

Additionally, we see in both methods that although there were improvements in efficiency allocation in the Cash plus Combinatorial bids, periods 11–15 and 16–20, the efficiency itself was just above 50%, initially. They improved by 6%, the results showed the level at 52% in periods 11–15 and 58% in periods 16–20. The Cash Only rounds of periods 1–5 and 26–30 were not included because there were no NMI's in the rounds.

Bidder surplus is the value the subjects gained above their opportunity cost. The average bidder surplus foregone denotes the surplus value the average subject scould have received if they placed the optimal cash and NMI value bids. Bidder surplus foregone can be envisioned as "the money left on the table;" the total potential surplus value with the optimal bids minus the realized surplus value. Figure 28 shows that bidders or subjects began losing less of their surplus value in the later periods of the Additive NMI value (rounds 6–10 and 21–25), which is consistant with subjects learning with experience. However, bidders actually lost more of their surplus value in the later combinatorial value NMI rounds (rounds 11–15 and 16–20). As mentioned previously, the combinatorial rounds may have been more complex for the subjects to understand.

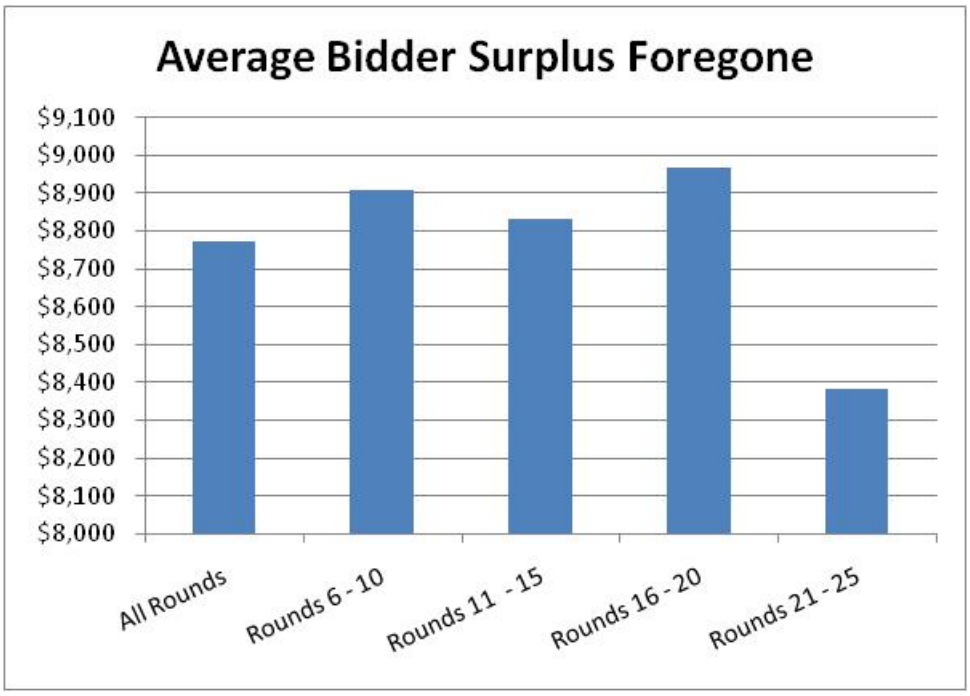

Figure 28. Average Bidder Surplus Foregone

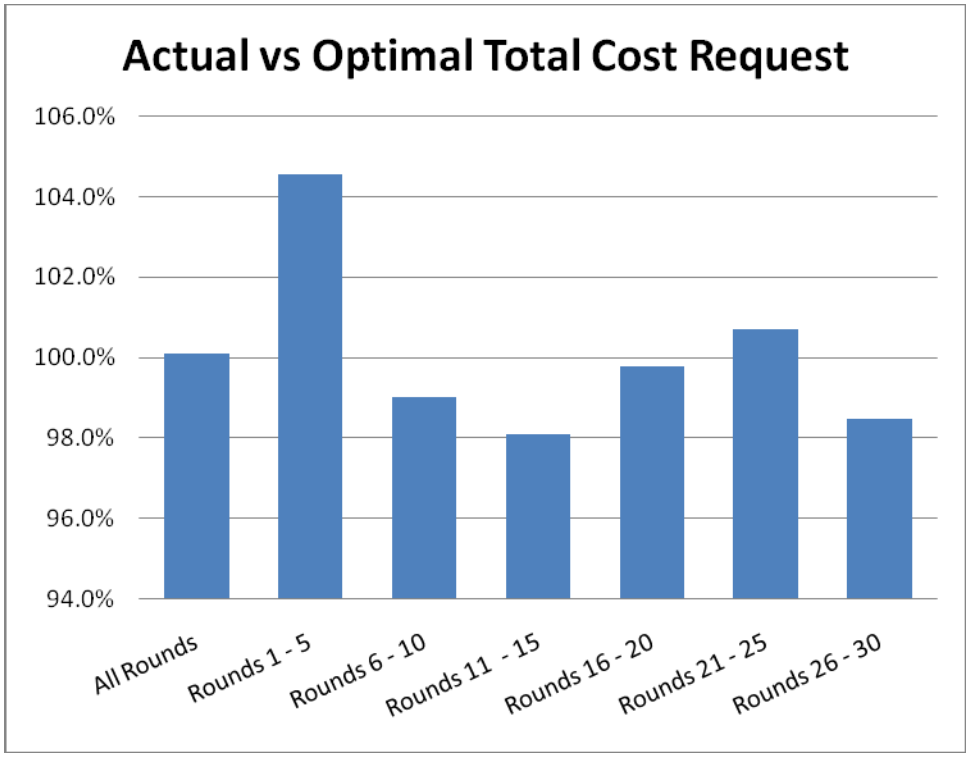

Figure 29. Actual vs. Optimal Total Cost Request

4. The Cost of Retention

The following results report the value and cost comparison to the retainee for the incentives they selected and Firm A's cost to retain the individuals. Also, reported are the value percentages and cost of only those individuals retain by Firm A in the scenario. The value for the bidders retained by Firm A and Firm A's cost to retain them is displayed in Figure 30. The overall average value in dollar amounts, attained by the bidder was $106,278. The overall cost to the firm was $103,674. However, results by round are more instructive. Notice value and cost are identical for the cash only retention rounds (1–5 and 26–30); when cash is the only incentive value and cost are necessarily the same. Value exceed cost in the NMI rounds, with ther difference growing slightly in the final NMI rounds as the participants learn the optimal bidding strategy.

These results demonstrate that Menu Method CRAM and Bid Method CRAM perform efficiency by providing the individual with incentives whose value to the retainees exceeds the firm's cost to retain. The differences indicated here here reflect just two NMIs and NMI values that are relatviely low relative to the opportunity cost at Firm B. In actuality, the differences are likely to be substantially greater as more NMIs are offered and some NMIs have significantlly higher values for at least some bidders..

Figure 31 demonstrates that on average, subjects received 95% of their optimal value in the CRAM process over all rounds; only 5% of their optimal value was foregone. For a complex discriminatory price auction with additive and combinatorial NMI values, this is a rather remakable outcome. Furthermore, the percent of optimal value captured clearly increases with experience in the auction. The complexity of discriminatory price price auctions, as well as complexity of the additive and combinatorial value NMIs, play a role in this lapse, causing bidders not optimizes there values consistantly. Clearly, additional instruction and experience would improve general bidder perfomance.

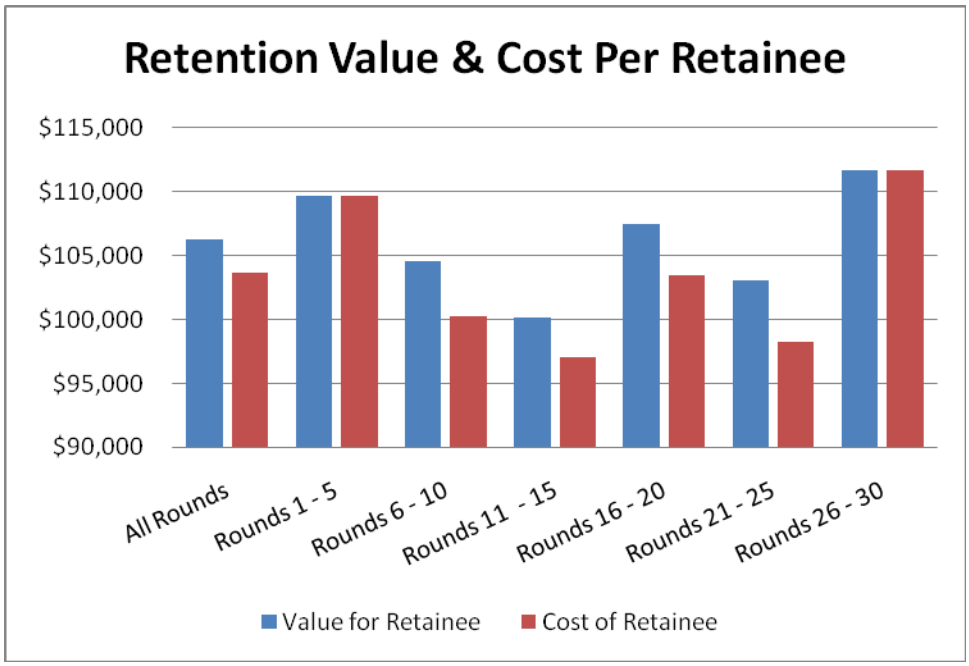

Figure 30. The Value and Cost of Retention

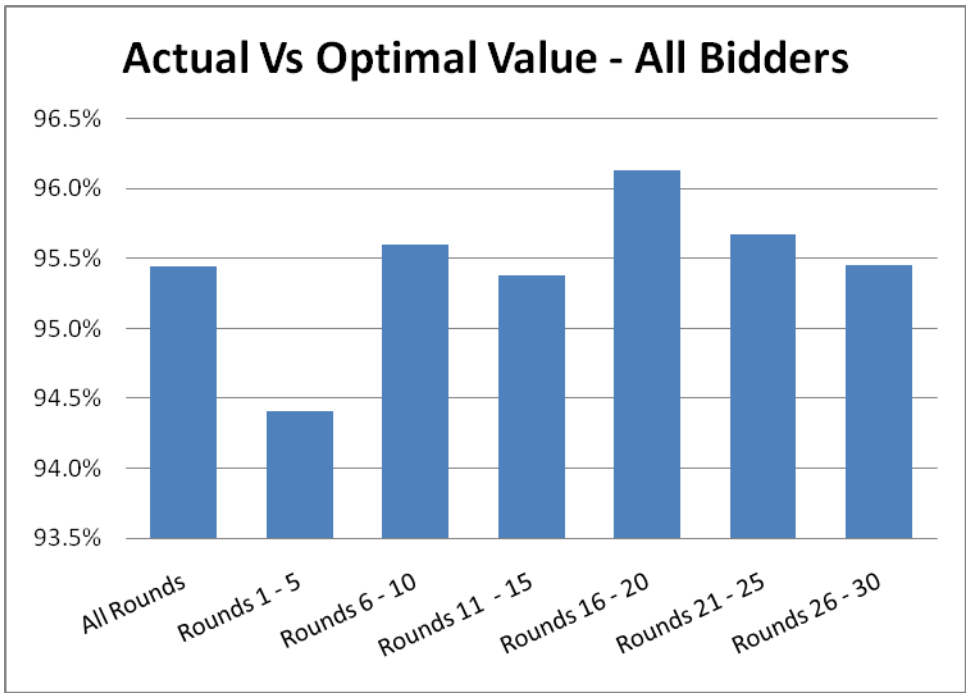

Figure 31. All Bidder Actual Value vs. Optimal Value

Figure 32 shows the relative actual and optimal value versus the cost of those retained by Firm A. This performance is slightly lower than for all bidders, as depicted above, because actual and optimal value is essentially the same for the employees separated to Firm B, unless they are inefficiently separated. Figure 32 focuses specifically on those participants whose pay was determined by the bids submitted because they were retained by Firm A. Again, this performance is remarkably good, with bidder values and firm costs registering over 92% of the optimal value across all rounds. Again, the data shows noticibale learning as the subjects more trhough the rounds (the second iterations of each auction alternative have substantially better results than the first iteration). Furthemore, the data shows that the bidders perform better in the cash only rouinds than with the additive NI values; perfomrance is the lowest in the combinatorial NMI value rounds. This mirrors the issues with complexity described above.

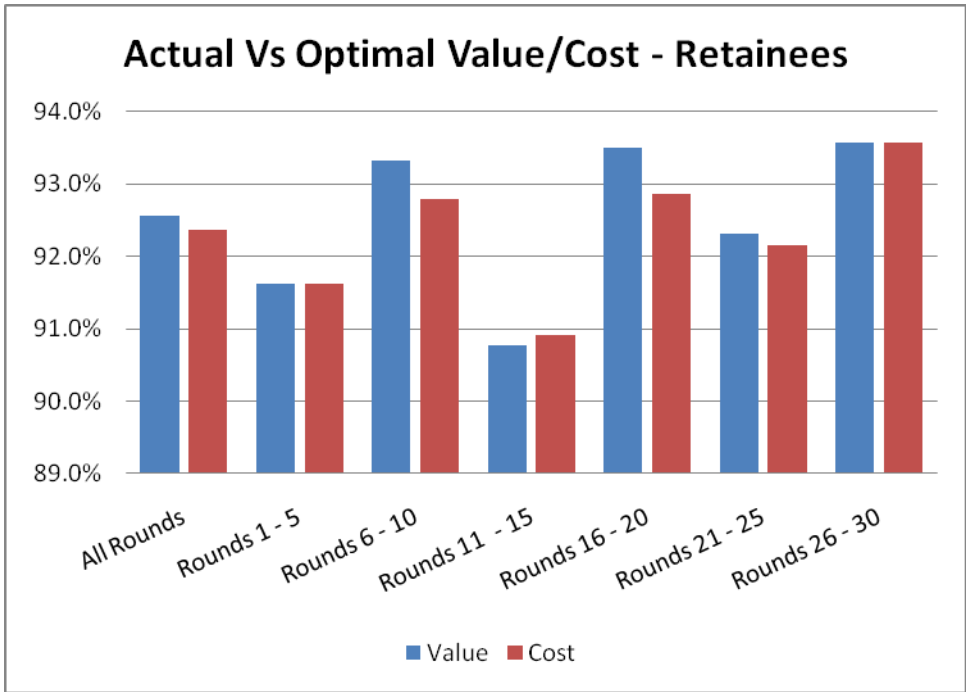

Figure 32. The Relative Value to Cost Comparisons

5. Errors in the Experiment

The experiment did reveal inefficiencies. Errors were noted in both CRAM methods related to the retention and separation of some bidders. The final analysis found some bidders were retained by Firm A, but would have been better off at Firm B. We called this phenomena "inefficient retention" (e.g., a bidder submits an $80,000 salary request and is retained by Firm A, but could have earned $100,000 from Firm B). There were 143 bids (~7% of all bids) where a bidder had a reservation wage above the salary they received from Firm A, and was inefficiently retained by Firm A (for a total value less than their opportunity cost at Firm B). In addition, there were "inefficient separations" noted in the overall results; bidders with opportunity costs or reservation wages below the cutoff for Firm A, but bid above the cutoff and were separated (e.g., a bidder submits an $120,000 salary request to Firm A and is separated because the Firm A cut off is $100,000; however, their Firm B salary is $80,000, so they should have been retained by Firm A for a salary below $100,000). A total of 164 bidders (~8% of all bidders) were separated from Firm A that would have been better off if retained. Finally, 84 bidders (~4% of all bids) were retained by Firm A and should have been retained by Firm A if they bid optimally, but given the sub-optimal bids they actually submitted, they would have preferred to have been retained by Firm B (e.g., a bidder submits an $80,000 salary request and is retained by Firm A, but could have earned $100,000 from Firm B, at the same time, the Firm A cutoff is $120,000; given their bid, this subject would prefer to be retained by Firm B, if they bid optimally they should have been retained by Firm A).

6. Summary

The labor market experiments conducted for this thesis produced results that were consistent with previous research related to CRAM. The final experiments were limited to Discriminatory Bid Method CRAM based logistical miscalculations. However, enough data points were acquired in the research and experiments, to compare the basic tenants of discriminatory price bidding under the Menu Method CRAM and the Bid Method. The results revealed a consistent pattern of learning by the bidders in the experiment and maximization of value > cost. The Cash Only salary requests were routinely close to their

optimal values. However, value to cost maximization was significantly lower when NMIs were incorporated into the compensation package, particularly for the combinatorial values rounds, 11–15 and 16–20. It appears that bidders had difficulty bidding their optimal NMI prices in both CRAM methods. There appears to be a correlation to this decline in value maximization and the complexity of the combinatorial rounds.

B. CONCLUSIONS

As the Navy Nurse Corps continues to seek new and innovative retention tools that can also provide a cost savings, CRAM with cash incentives must be at the top of their list. Cash bids in the discriminatory price auction are close to optimal; NMI bids are also reasonably efficient when values are additive. Bidders may require additional instruction when NMI values are combinatorial. The mechanism gives the service member the incentives they most value and saves the Navy a substantial amount of money in the short and long run. Although the experimental population is not made up of Navy nurses, the experiments are applicable to any community. The NMIs in the experiment were generically identified as NMI 1 and 2, so the results should be general across Navy communities. The Menu Method CRAM and Bid Method CRAM will allow junior and prior-enlisted Nurse Corps to bid on the NMIs they value most, such as homesteading, sabbaticals, assignment choices, childcare, etc. and save the NNC possibly millions of dollars in the process.

1. The Primary Reasons for the Study

The experiment answers the primary question for this thesis in detail. The independent and interdependent effects of monetary and non-monetary incentives utilizing a discriminatory price auction were identified in the experiments. They clearly demonstrate a positive learning pattern throughout the four sessions, and within each group of sessions. Subjects learned as they progressed in the experiment, as evidenced by their ability to bid closer to their optimal value in the Discriminatory Menu Method and Bid Method CRAM experiments. The Cash Only and Cash plus NMI's with additive effects were the most effective at getting to an efficient solution. The effectiveness of the

participant's bidding strategies improved as they progressed in each session. The results of the Cash Only salary request comparison would suggests that if the Navy Nurse Corps were using a Cash Only salary auction, the target group of nurses would bid close to their optimal price, which would be above cost. The bottom line of these results is a huge cost-savings mechanism for the Navy Nurse Corps, and a value driven gain for those nurses retained. Numerous studies report similar results to this experiment.

The secondary research question addressed specific issues in the NNC community related to value for NNC officers, decision-making behavior of NNC officers, retention of specific groups within the NNC community, and possible cost effectiveness of a program, such as CRAM.

2. Secondary Questions

The secondary research questions look to examine specific issues in the NNC community related to value for NNC officers, decision-making behavior of NNC officers, retention of specific groups within the NNC community, and possible cost effectiveness of a program, such as CRAM. According to a CNA study used for this thesis, junior and prior enlisted NNC officers highly value many of the same incentives as SWOs in Brown and Burr's research (Browning & Burr, 2009). NMIs, such as homesteading, assignment of choice, sabbaticals, and more control over career choices, seem to be highly valued among nurses (Whitmore, Hill, & Bickett, 2009). Many secondary questions will be answered in future labor market experiments conducted specifically for NNC officers. However, we can acquire many beneficial observations from this experiment.

The research indicates that subjects increased their ability to judge their value and bid accordingly as their experience in the auction increased. Rather than continue to bid too high and increase their bidder surplus, or bid too low and sacrifice profits to increase their probability of retention, they returned to some value equilibrium point, closer to their optimal bid. It was similar in all other rounds/periods also. Subjects seem to adjust their bidding strategy for the Cash Only bids in the later rounds, as they get closer to the optimal salary request. This would suggest that discriminatory Menu Method CRAM and

Bid Method CRAM could both be an effective retention tool for the NNC. The two CRAM methods would also allow NNC leaders to create the optimal mix of monetary and non-monetary incentives for junior and prior-enlisted officers.

C. RECOMMENDATIONS

The results and findings in this thesis are neither conclusive nor complete. There are numerous areas that should be explored and tested before CRAM can be fully operational in the NNC. However, there is some value the Department of the Navy, Bureau of Navy Medicine, and the NNC community can gain from tools, such as CRAM. The Department of the Navy should increase funding for research at NPS related to the development of CRAM and its implementation. Based on the results of the research, the Bureau of Navy Medicine should examine utilizing some form of Menu Method or Bid Method CRAM in other communities where retention goals are consistently not met.

The NNC should begin continuous funding and support of research related to Menu Method and Bid Method CRAM. In the long run, the cost saving from these auction mechanisms would offset any initial investment. Based on the generational differences in the NNC, junior nurses and prior enlisted may desire different NMIs or cash as a retention incentive. CRAM allows the officers to select incentive packages that address their individual needs, while maximizing their value, and improving quality of life. Once a year, one or two NNC officers attend the Naval Postgraduate School, Graduate School of Business and Public Policy. The nurses could be assigned to the CRAM research team, furthering the research for the use CRAM methods in Nurse Corps, and conducting experiments related to Nurse Corps officers incentive programs.

Additionally, the NNC can begin implementing small, inexpensive NMI programs and conducting internal cost analysis to further develop a program, such as Menu Method or Bid Method CRAM. Homesteading or more control of one's career are NMIs that could be implement at small, local and regional commands with little direct cost to the NNC. The programs can be carefully monitored and slowly progress to the larger commands as CRAM development and usage matures. Senior leaders in the NNC are very concerned and focused on retention issues related to junior officers and prior

enlisted nurses. The Menu Method and Bid Method CRAM should be their primary tools for selecting monetary and non-monetary incentives for retention of junior and prior enlisted NNC officers. The CRAM methods can become the basis for implementing their retention plans and policies, measuring effectiveness of their programs, and retaining higher quality skilled nurses.

D. FURTHER RESEARCH

The limits of this research directly correspond to the scarcity of time and resources. Yet, it does allow many other avenues to explore in future researchers interested in auction mechanisms. The expansion of the research is inevitable; therefore, future research will build upon this thesis and many others. Recommendations for future research include:

- Data gathered to date should be disaggregated between Bid Method and Menu Method CRAM to further distinguish between the performance of these two mechanisms.
- Researchers should perform future experiments on specific, targeted officer communities, such as the NNC.
- Conduct research and analysis on the cost of providing different NMIs to NNC officers or other communities and inputting them into a CRAM labor market experiment.
- Conduct labor market research using partial and full-information CRAM.
- Perform a cost benefit analysis for NNC value vs. cost for cash bonuses and NMIs.
- Research should continue developing CRAM software and product design

The Navy Nurse Corps continues to prove it is an innovative leader in delivering healthcare to the Navy population they serve. Navy Medicine cannot function without the fuel that feeds its manpower system, the nurses serving in the NNC. Therefore, retention is a priority for continuing operational and humanitarian success. Recognizing and addressing retention at this time, while retention is relatively high, is a priority. Junior nurses are leaving the active duty NNC at an alarming rate for a number of personal reasons described in this thesis. Prior enlisted officers are retiring at a higher rate because they have nothing left to serve for in the NNC. The CRAM, auction mechanism in the

NNC can be the next innovation that redefines retention incentives in the U.S. Navy. As usual, the Navy Nurse Corps should be the organization that takes the lead and blazes the trail on retention mechanisms in military medicine.

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APPENDICES

The guide below is included as a reference for the different appendices. The following link connects to the different appendices mentioned in this thesis.

http://edocs.nps.edu/npspubs/scholarly/theses/2010/Mar/10Mar_Levy_Appendices.pdf

Appendix	Description
A	CRAM Instructions
B	Survey Table
C	NMP Survey Results Nurse Corps
D	Nurse Corps Focus Group
E	GAO Report
F	Manpower Definitions and Terms
G	Types of Experiments and Experiment Design
H	Plott on Experimental Design (Plott, 2001)
I	Holt Document
J	Consent Form
K	Survey Flowchart
L	Lab Layout

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